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MICROCOMPUTERS IN TRANSIT

A Software Handbook

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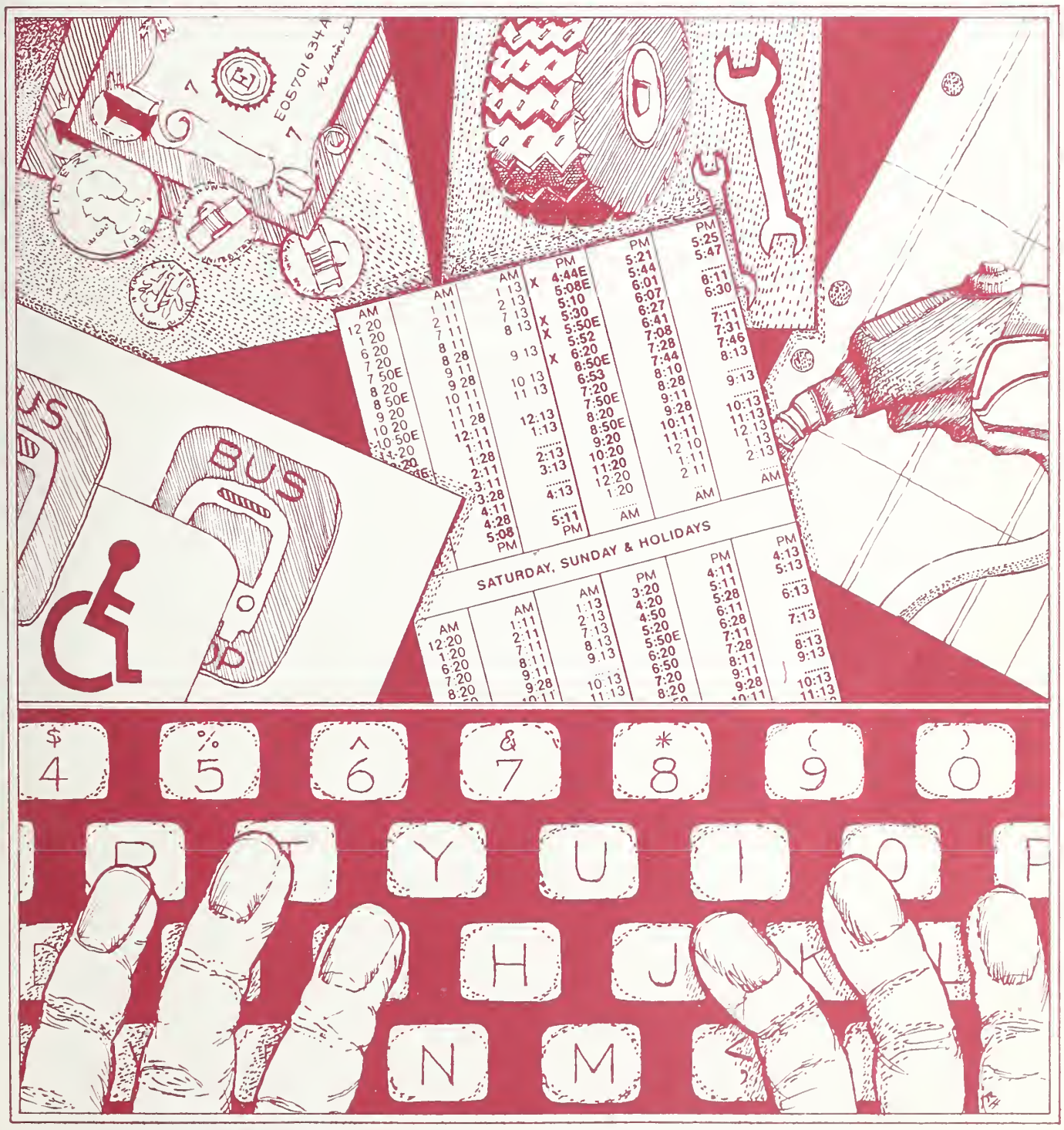

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Microcomputers in Transit: A Software Handbook

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July 1984

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16. Abstract

This handbook introduces management and staff of small to medium sized transit agencies to the use of microcomputers in transit operations. It describes the types of computer programs of use in this industry, and documents applications of some common ones.

The handbook is in two parts. Part I describes a process for identifying appropriate use of microcomputers, and introduces the various types of computer programs. Chapter 1 introduces the components of the microcomputer system. Chapter 2 outlines a process for identifying worthwhile and feasible uses of a microcomputer in the agency, by reviewing the various tasks which are candidates for automation. The following 5 chapters introduce different types of programs by describing their use and things to look for in selecting a program. Chapter 3 discusses generic software, including spreadsheets, database managers and word processors. Chapter 4 describes application software, programs written to accomplish a particular task in the transit industry. Chapters 5, 6, and 7 concern operating systems, programming languages and utility programs respectively. Finally Chapter 8 discusses some considerations in introducing a microcomputer into the agency.

Part II documents applications of generic programs, primarily spreadsheets, in the transit industry. Each application is illustrated, and documented with notes permitting reconstruction of the application by new users.

This handbook is a companion document to Microcomputers in Transit: A Hardware Handbook.

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PART I

MICROCOMPUTER SOFTWARE FOR TRANSIT

CHAPTER 1

INTRODUCTION TO PART I

Objectives of the Handbook

Every guide to selecting a microcomputer emphasizes the importance of selecting appropriate programs or software, even before choosing which hardware to buy. The purpose of this handbook is to describe a strategy for selecting software, provide an overview of the spectrum of available software with some of its uses in the transit industry, and to provide an introduction to the concepts and vocabulary required for software selection. The handbook documents a number of applications which have been developed and used by transit agencies.

The material presented here is intended to be of most use to management of small to medium-sized transit agencies exploring the potential uses of microcomputers in their operations. It is assumed that the user has little or no prior experience with microcomputers. Familiarity with the applications described in this handbook will give the agency access to many benefits from a microcomputer and will provide a foundation for evaluation of more complex and more specialized computer applications.

The Role of Microcomputers

Microcomputers are relatively inexpensive and easy to use. These characteristics have made data processing capabilities available to many users who did not formerly have the financial resources or expertise to use computers. Furthermore, it is feasible to perform tasks on microcomputers which did not warrant the fixed costs of automation several years ago. These conditions are most obvious in the small to medium-sized agencies which were not formerly able to support a staff person to oversee computer applications, nor to justify the cost of developing applications. The benefits of having data on system performance (costs, maintenance, and so on) accessible and manageable through automation were not available to these agencies.

The transit industry is rapidly recognizing the promise of this technology, and adopting it accordingly. A substantial number of agencies are using micros for a variety of tasks, and many more are in the process of acquiring one. One of the first areas where many operations realize benefits from their microcomputers is in the application of generic programs. In the longer term, more specialized application programs, either custom developed for a particular agency, or for the industry as a whole, will have profound impact on the management of transit operations.

The "microcomputer revolution" is still underway. Development of new technology, software to take advantage of its capabilities, new con-

cepts in software, and a more widespread understanding of the uses of computers is taking place rapidly. Whatever developments may take place in the future, the capabilities of even the present generation of technology will take time for the industry to digest.

Emphasis in this handbook is placed on the use of "generic" software packages, such as electronic spreadsheets, file managers, word processors, and data base managers. These programs are relatively inexpensive, powerful, and very versatile and can be used by people who are not computer specialists. Due to these characteristics they offer many benefits in transit operations: they turn the microcomputer into a flexible tool, completely controlled by the user, which can be applied to a wide range of transit management problems.

Components of the Microcomputer System

A microcomputer system consists of three elements: the program or software, the computer itself with its attachments or hardware, and an operating system which links the two. These three elements are mutually supportive, and must all be compatible.

Software

The application program, or software, is the actual reason for computer use. It is the element with which the user comes into daily contact, and which makes the machine either valuable or ineffective for an application. In all selection decisions concerning the system, it is the final application, and thus the application program, which is the bottom line. A program may be purchased or obtained ready-to-use, or it may be written in a programming language by agency staff or an outside programmer for your specific purpose.

Hardware

The hardware is the tool which performs the tasks defined by the program. The core is the computer itself, made up of the microprocessor and components within the computer. Other components, called "peripherals," are attached to the computer. They may include disk drives, the keyboard, monitor, printer, and additional optional equipment such as modems for communications and hard disks for data storage. The hardware items must be powerful enough to perform the tasks required by the program within the context of the agency's operation. More information on hardware components and selection can be found in a companion handbook, entitled Microcomputers in Transit: A Hardware Handbook.

Operating System

The operating system is a master program which acts as interface between the hardware and the application software. It controls the hardware as required by the program, and performs a number of fundamental tasks common to all applications. For example, when a program requires data to be printed, it tells the operating system, which then alerts the computer to send the message and data to the printer. A

similar function is performed for the display screen and keyboard. The operating system includes programs which allow the user to perform a number of routine housekeeping tasks, such as copying disks. Operating systems, programming languages and utilities, which are all programs but have no actual application by themselves, are called "system software." They support the development and use of the actual application software.

Assembling a Microcomputer System

Acquisition of a microcomputer system for a transit agency includes three major elements:

-selecting of software
-selecting of hardware
-incorporating the facility in the organization

The hardware is tangible and most easily perceived; however, the software and incorporation of the tool in the organization are the keys to benefiting from the system. These two elements should drive the choice of hardware to be used.

The combined cost of the software, training, staff time dedicated to incorporating the system in the organization, and, possibly, consultants, is likely to equal or exceed the cost of the hardware itself. In order to permit economical and worthwhile introduction of the system to the agency, the factors which affect these costs should receive careful planning and evaluation. This means considering **what** the computer will do in the agency (through needs assessment and software selection) and **how** it will be done (through an implementation plan).

Structure of Part I

Material is presented in the order in which it is likely to be encountered in assembling a system. For this reason the chapters on generic and application software precede those on "system software" (operating system, programming languages and utilities).

The following chapter, System Design, discusses some of the issues which are encountered in assembling various pieces of software and hardware which are intended to work together in a coordinated way, such as compatibility, transferability, support, cost, etc. Chapters 3-7 each address the characteristics and selection of a different type of software. Flexible "generic software" which is likely to be the first use of the microcomputer, and can provide immediate benefits, is discussed in Chapter 3. "Application Software," programs written for a specific purpose, are described in Chapter 4. Chapter 5 deals with operating systems, required to run the generic and application programs. Programming languages, which may be useful for writing custom-tailored programs are discussed in Chapter 6, followed by utilities, which may enhance the use of your microcomputer, in Chapter 7. Chapter 8 addresses the issues involved in implementing a microcomputer system.

Chapter 3 is complemented by documented examples of over 20 applications in use in the transit industry, which are included in Part II. A glossary of technical terms and list of references are included in Appendices A and B.

General Perspective

There is no right or wrong microcomputer system or way of using microcomputers in a transit agency. There are only systems that work more or less well for the agency and individuals concerned.

Microcomputers offer a tremendous resource to management and staff in the transit industry. In the long run they will undoubtedly become as entrenched as the typewriter or adding machine, although they are far more versatile than either of those tools. At present their enormous potential is still being explored, and their role is limited only by the creativity of users and the ability of organizations to incorporate change.

Discussion in this book avoids as much as possible the characteristics of particular machines, or particular products. The material is presented in general terms which apply to any product of the type being discussed.

CHAPTER 2

SYSTEM DESIGN

This chapter discusses the general considerations in selecting microcomputer software for transit applications. The characteristics of transit operations, along with the current status of the technology and software development, suggest a number of general guidelines to follow in assembling a software system.

A transit operation is rich in processes which could be automated. Scheduling, dispatching, service records, work orders, vehicle histories, ridership data, personnel records, financial records, etc. are all activities which could potentially benefit from automation. Furthermore, these tasks are all interrelated, as data from one is used as input to others.

Automation of some selection of these tasks is a challenging problem, both technically and organizationally. It requires a careful evaluation of the benefits to be obtained by automating each, selection of a set of tasks to be included in the system, design of the system, assembly or creation of the system, and implementation, including training and procedural changes. The final product will be a collection of pieces of software, staff who are able and willing to use them, and a computer capable of running them.

The Value of Computers

In spite of its internal technical complexity, to the user a computer is like a mechanical tool. Many difficulties in its use are a result of the range of ways it can be used, the number of individuals in an organization who are involved with it, the interrelationships between its uses and the newness of the tool to many users. The actual capabilities of the computer are not very complicated.

What a Computer Can (not) Do

There are three things which a computer does well. First, a computer is very good at long and tedious numerical calculations. An example of this would be reducing a month's ridership data to summary statistics such as average weekday, Saturday, and Sunday ridership.

Second, computers are also excellent at repetitious tasks. The "what-if" use of spreadsheets takes advantage of this characteristic. The computer will very quickly recalculate a series of values or results for a number of different starting assumptions you want to test. This allows you to quickly evaluate different scenarios. For example, an operating budget can be recalculated to show the cost of several alter-

native amounts of service offered. Word processors also take advantage of this strength in allowing rapid production of numerous versions of a document.

Finally, large amounts of data can be stored in an organized manner, and retrieved in the desired form very quickly using an automated database or file manager. This quality allows the user to approach data in a much more flexible manner than is possible using manual database summaries. The same set of work order data, for example, could be used to summarize the use of various components, labor costs for completing various tasks, maintenance costs per mile for each vehicle, failure rates for each part, or other information. Although the same information is available from manual work order records, the labor required to extract it is prohibitive.

In summary there are three benefits to be obtained from automating a process:

1. Automation of processes involving **long or repetitive calculations**, may result in time savings.

2. Tasks which require a trial and error method of **testing various scenarios or assumptions** may also be done more effectively on a computer.

3. The increased **availability of information from data bases**, may permit more informed decision-making.

Computers do not have judgment (at least not yet). Any process which requires subjective or arbitrary decisions or judgment calls may not be appropriate for automation. For example, computers by themselves cannot evaluate the performance of a particular route; they can only make an increased amount of information as defined by the planner available to enable the planner to do this.

Benefits from Use of Microcomputers

Benefits from automation can take a number of forms, which may be summarized as:

1. **Time savings.**

2. **Increased flexibility.**

2. **Additional information.**

It is difficult to quantify benefits or translate them into dollar values. It is also hard to predict the actual effect of introducing microcomputers to an organization with its complex personalities and

interactions. However, realistic expectations of the capabilities of microcomputers will avoid morale-dropping disappointments and encourage users to make the most of the possibilities.

Time savings. Time savings may be achieved by automation, as the computer may allow the user to calculate, sort information, or try out alternatives faster than would be possible by manual techniques. These savings may allow the user to concentrate more on the data and the process than on the mechanics of generating a result. The time saved may allow tasks to be performed better and more completely. But the time saved is very unlikely to result in lower staff requirements.

Increased flexibility. The increased flexibility a microcomputer may offer is a by-product of time savings. By saving time in evaluation of a projected scenario, the user may be able to consider a range of alternatives in the time it previously took to evaluate a single one. An example of this type is in budgeting. The numerous assumptions incorporated in a budget, such as budgeted amount of service, projected fuel cost, and wage rate can be changed to examine the effects of different assumptions on expenses. In negotiations with state or local officials concerning the budget, revisions can be made quickly and easily. This increased flexibility is at least a convenience, and at best a valuable asset for decision-making staff, who can consider a wider range of alternatives with little additional effort.

Additional information. The third benefit of microcomputers is the additional information they make available to managers, which may be used for more complete analysis of problems and better decision-making. An example of this is the use of a database manager to manage customer service records. The transactions are entered daily in the computer, and then provide a source of reports on complaints by route, complaints and commendations by employee, complaints not yet resolved or responded to, and so on. These reports may help the manger to identify and diagnose problems quickly, and to manage the process of responding to complaints more easily and efficiently.

Planning the System

There are numerous functions in the transit agency which could be automated, but which would not benefit from it. Many of the cost savings from automation are imaginary; for example, time saved adding figures in a manual process may become time spent entering figures in an automated one. Each potential application should be considered in order to identify real benefits which could be obtained by automation. If a manual process is working well and there are no clear benefits to be obtained by automating it, it should probably be left as is. "If it's not broke, don't fix it." On the other hand, automation may create, not solve, problems with procedures that do not work manually.

In order to identify the viable uses of a microcomputer in your agency, and a plan for introducing one, a five-step needs assessment process should be followed:

1. **Identify tasks** which are candidates for using a microcomputer.

2. **Identify programs** which are available for those tasks.

3. **Compare the tasks to the programs** identifying feasible application programs.

4. **Select system elements.**

5. **Develop implementation plan.**

This process is complicated by the fact that many people are learning about microcomputers at the same time that they are planning for them. A cycle of considering your needs, learning about microcomputer use, and reassessing your needs invariably takes place.

The learning process may be eased by taking advantage of opportunities to learn about microcomputers and get a basic understanding of how they are used. If you know anyone who is using one, arrange to see how they use it, and even to try it yourself. Consider taking a general course on microcomputers if one is available in your area. Courses on microcomputers in transit are offered periodically by UMTA and other institutions around the country. Browse through some of the many microcomputer periodicals available. Join the Transit Industry Microcomputer Exchange (TIME) User Support Group to get their newsletter (see Appendix B).

Other transit professionals are also a valuable source of information. Find out how other agencies of your size are using microcomputers, what has worked for them, and what has not worked.

A key element of this process is involving the staff who will later be using the machine. Many people, especially those who have been doing things a certain way for years, may feel overwhelmed or threatened by the idea of microcomputers. The success of using the microcomputer depends on the interest and support of these people. It is important to involve them in identifying the possible role for the system in their areas of responsibility. If possible, arrange for staff who will be using the microcomputer to have an opportunity to try using one in a low pressure, supportive situation.

The process of selecting tasks for automation is not an exact science, and there is no "right" solution. It is important, however, to think through each candidate task carefully using the five steps as a guide.

Step 1: Identifying Tasks

Before evaluating any task for automation it is important to define it as clearly as possible. The more completely a task can be described, the more accurately the benefits and costs of automating can be assessed, and the more appropriate the solution will be. The descrip-

tion of the task should include answers to the questions listed in column 2, Task Description, and 3, Task Needs, of Figure 2.1. The questions in column 2 deal with characteristics of the task as it is currently being done. The questions in column 3 suggest general considerations which might make the task more or less suitable for automation.

The questions in Figure 2.1 fall into five categories, which clarify whether the tasks include functions suitable for automation, and whether the potential exists for benefits of time-savings, flexibility or increased information. The first set of questions, task analysis, generates a detailed description of the task and clarifies what would be involved in automating the task itself. The question on repetition indicates whether automation could facilitate repeating the task, and helps to quantify potential time savings on an annual basis. The potential of automation to improve the performance of the task by increasing the usefulness and completeness of information generated is addressed by the third set of questions.

Possible constraints on automation include the interest and abilities of staff who would be involved, the interrelationships between tasks, and the forms in which data is input to the program and reported or output by the program. The fourth and fifth set of questions concern these topics.

Once the task has been clearly defined in this way, the potential role of automation can be better understood. The answers to these questions provide a basis for comparison with the programs that are available.

Step 2: Identifying Programs

Having reviewed the agency functions which might be suitable for microcomputer applications, the next step is to look for programs which could fill your needs.

Sources of information. A good overview of software being used in the transit industry is provided by two free sources. The Microcomputers in Transportation: Software and Source Book (see Appendix B for information on obtaining this) provides a listing of programs which are available or being developed, including information on what they do, what system they run on, and how they are available. The Transit Industry Microcomputer Exchange (TIME) Support Center publishes a newsletter, "Time Capsule," which includes brief articles about relevant topics and lists of programs developed under Urban Mass Transit Administration (UMTA) sponsorship and distributed by TIME. (Their address is included in Appendix B.)

The best source of information on a program which is already in use is **someone who has used it**. Many difficulties with programs may be hard to foresee or seem minor until they occur in the actual application. Other transit agencies in similar circumstances to your own who have implemented a particular program or application may be located through the American Public Transit Association (APTA), TIME, or UMTA. A signi-

CATEGORY	TASK DESCRIPTION	TASK NEEDS	PROGRAM EVALUATION
TASK ANALYSIS	What steps does it include? How long does each step take?	Are any or all steps suitable for automation? Might time be saved by automation?	Does a program exist to do the whole task? Does a program exist to do critical steps of it?
REPETITION	How often is it done?	How much time would be saved annually?	How much time would it actually save?
POTENTIAL	How could the performance of the task be improved? (More or different analysis, faster turn around, etc.) Does the information being used have additional untapped areas?	Should the process be changed, whether or not it is automated? Is it constrained by the current method? Would automating the process give users access to additional information of value to management?	Can using the program improve the performance of the task? (More complete analysis, more accurate results)? If there are any other uses for data, does the program give added flexibility in using the data?
LINKS BETWEEN TASKS	Where does the input information come from? In what forms is the information entered? Where does the output go? What output is required?	Is data coming from or going to another process? What types of data input and reports are required?	Is the program compatible with a program being used for an adjacent function? What would be involved in inputting the data to the program? Can the program generate the required reports?
STAFF ISSUES	Who does it?	Are they receptive to using a micro? How active a role are they willing and able to take?	Does it suit the interests and abilities of the staff who will use it? Who will use it? What training would be required?

Figure 2.1 Task Assessment

ficant reason for obtaining the assistance of a consultant in the system selection process is that he or she may be familiar with the range of programs available, and the experiences that various agencies have had with them.

A less reliable source of information concerning commercially available software is sales staff. Many employees of computer retail outlets have never used the products they are selling, and do not know what they can or cannot do. More accurate sources of information on commercial programs are the instructions, or documentation, which come with the program, reviews of programs in magazines (see the Appendix for a partial list), and users who have had experience with the program.

Other more obscure sources of information are available to those who have the time and inclination to explore further. A number of periodicals, some of which are listed in the Appendix, cater to different segments of the microcomputer market. Many regions have "user groups," which provide a forum for exchange of information between microcomputer users sharing a common interest, such as the same type of equipment or similar applications. Information on user groups in your area can be obtained from local computer stores or from directories in some of the magazines.

An explosion of software development is underway. Programs are becoming more powerful, more complete, more refined, and more eclectic, resulting in an enormous pool of software of all types from which to draw. These programs can be grouped into two types: (1) generic and (2) application. Chapters 3 and 4 describe them in more detail.

Generic programs. One of the most revolutionary aspects of the microcomputer technology is the development of sophisticated tools which can be used for all sorts of applications. There are three general types of generic programs. The most widely touted and dramatic of these is the **electronic spreadsheet. Word processing** has resulted in fundamental changes to the way written communication is used and is probably the first on many managers encounter. **File managers** have an enormous number of applications. One can learn enough of any of these to be useful within hours of first exposure. Experience with them further increases the versatility and power of their use. Other tools, such as **database managers** and **statistical programs** are equally versatile, but require more effort and experience to use effectively. Generic programs are relatively inexpensive ($50-$700 range). They require the user to set up the specific application. Generic software is addressed in Chapter 3.

Application software. Application software includes programs which are written to perform a particular task, such as inventory, accounting, and so on. They include off-the-shelf programs, written for a broad market of users in various businesses and purchased at computer stores, and industry specific software developed for the transit industry.

Numerous programs are on the market to perform specific, frequently required functions. Examples of this include financial management and

accounting packages, inventory, project programming, and many others. These packages are specific in their design, and are often intended for small private-sector businesses, so you must consider whether their particular characteristics are compatible with your application requirements. On the other hand they are relatively inexpensive, and, if they fit right, could be a cost effective solution.

An increasing amount of transit specific software is being developed. Sophisticated packages are available from numerous private sources for fleet management, scheduling, financial management, etc. In addition, a number of programs have been developed under UMTA funding, and are in the public domain. Although many programs of this sort are available, they may be designed for some unusual type of microcomputer, or more likely, may not be complete yet. However, with the amount of development currently underway, this situation should improve in the near future.

Specialized applications, such as particular transit management functions, have a relatively small market to support them. Within the transit industry, which is a limited market to begin with, variations in size, organization, operational environment, and other characteristics prevent one program from being directly applicable to a large number of systems. Because of the small market, the costs of developing application specific software must be distributed between a smaller number of users, resulting in the fairly high costs of transit specific software for all.

Step 3: Comparing Tasks to Programs

Once you have identified the range of programs available for the tasks you have in mind, you can obtain a realistic image of what applications are feasible for your operation, and what types of software will be effective.

Program effectiveness. It is helpful to keep in mind the "80% rule," which points out the trade-offs to be considered in selecting system components and software. The cost of acquiring a solution to 100% of the problem will be several times the cost of solving 80% of the problem. A corollary to this rule is that the system which solves 100% of a problem may be less flexible than that which solves 80% of the problem.

The questions summarized in column 4, Program Evaluation, of Figure 2.1 indicate some considerations in matching software to the applications you would like to accomplish. These questions clarify the benefits a particular program can provide for each task in the form of timesavings, increased flexibility, or more useful information. The ability of the program to meet constraints resulting from agency staff and from the character of the particular task are also addressed. While much of this information cannot be quantified, it does provide an understanding of the balance between program cost and potential benefits.

When this step is completed you will have a fairly clear image of what is reasonable to expect a microcomputer system to contribute to your agency. The most promising applications will have been identified. You will have a realistic idea of the degree of automation to expect for each task. The number of users of the system will have been identified and an estimate of the amount of data to be generated will be possible.

Logistics. With the background already assembled it should be possible to make a first stab at defining an **effective hardware configuration**. Without exploring specific brands or technical specifications the general layout can be selected.

A first step is to identify **who will use the computer**, and how much time each one might be expected to use it. Typically most computer use will be for routine tasks performed by clerical or technical staff. Except in very small agencies most use of computers by top management will be for infrequent, one-time, problem solving. The amount of time required for each user to input data, perform any analysis required and generate reports provides a starting point for describing a hardware system.

The **number of machines** required can now be estimated. If the machine is expected to be in use more than two-thirds of the time, a second computer or terminal is probably required. Competition between users discourages additional uses of the machine.

The **location of the microcomputers** should also be considered at this time. The amount of use the facilities receive depends partly on their accessibility to each potential user. Ideally the computers should be located at convenient work stations conducive to productive work. This arrangement allows reference materials and supplies to be accessible to all users. It is unusual for one individual to dominate the use of a machine sufficiently that it should be located in their personal work space. In addition to these considerations, minimal environmental conditions are required to protect the computer from damage. Fumes and dust may be harmful to the computer, as may extremes of temperature. For the summer comfort of users, air conditioning is usually desirable.

Hardware requirements. Several hardware elements of the system should be considered at this point, because they may have specific implications in the selection of software.

Will you need a **hard disk**? When the microcomputer is turned off all of its internal memory, except for some permanently programmed memory, is erased. Any programs or data you wish to save for future use must be recorded outside the machine on "mass storage" before it is turned off. The most common form of mass storage is the floppy disk or diskette. These look somewhat like a very thin 45 rpm record, which is coated with magnetic material, inside a permanent plastic sleeve. Each one may hold up to several hundred pages of information, depending on how it is formatted by the particular operating system being used. Alternatively, a hard disk can hold vastly more information than floppy

disks. A hard disk is also a magnetic storage device but comes mounted permanently in a sealed box.

There are three reasons for selecting a hard disk. First, applications which require large amounts of data are faster and more convenient with the use of a hard disk. Second, data stored on hard disk can be shared by several computers hooked up to it in an integrated information system. Finally, the convenience and high speed with which it can read and write make a hard disk particularly valuable for database and statistical applications.

Will you need a **networked or multi-user** system? If you need more than one machine, the amount of interconnection between them should be considered. There are two ways in which interconnection can be valuable: (1) in sharing of data and software, and (2) in sharing of peripheral equipment.

In some situations several users may need to share programs or data. Often a small enough amount of data must be transferred between users that it can be passed on a diskette from one user to another, or different machines can be used for tasks using different data. In a similar way data can be routinely transferred from one machine to another by telephone or by connecting microcomputers directly (if they are close enough). In certain rare situations it may be necessary for two users to have access to the same data continuously; for example, a customer information office might need access to current information on delays or schedule adherence. This requires two microcomputers to have access to the same database, usually on a hard disk. They must be physically connected by cables and hardware, and also coordinated by software which can manage the requirements of the two users and prevent conflicts; this constrains the selection of software for the system. Alternatively a multi-user system can be used in which both people use the same computer and memory; this arrangement also limits the availability of software.

It may be economical in some agencies for users of several microcomputers to share some hardware components, such as printers or a hard disk drive. This can be accomplished either with a physical arrangement of cables and switches, or by using software to switch control of the peripherals between computers. In either case, coordination of peripheral use is a less complex problem than sharing data on programs.

You may be able to benefit from **coordination with another agency** having similar requirements. At least you can benefit from sharing experiences and discoveries. At most you may be able to share in the development cost of a common application need. If this coordination is desired it will constrain your selection of an operating system, and possibly also hardware and application software.

Step 4: Selecting System Elements

It is in this step, when the various pieces of the system are selected, that the future effectiveness of the system in your agency

will actually be determined. The selection process is somewhat like choosing puzzle pieces from a box containing several puzzles while trying to make sure they all come from the same one. The various pieces will include, at the minimum, one or more generic programs and an operating system, possibly an application program or two, a programming language for the adventurous, and perhaps a utility or two.

Five families of selection considerations contribute to choosing an effective group of programs:

Technical considerations are required to select software consistent with the general characteristics and scale of the microcomputer system being considered. If a multi-user system is being considered, or a hard disk will be used for data storage, support for these attributes becomes a selection criterion.

System considerations ensure that the various pieces of software purchased will work together and complement each other. Transferability of data between programs and use of a consistent operating system both contribute to a well integrated collection of programs.

User considerations may actually be the key to the extent of use of the system, since the staff using the microcomputers are most likely to further their use. Ease of use of the programs, flexibility, good documentation and sources of support, all stimulate exploration of new applications.

Cost of the microcomputer system should be reasonable for the benefits to be obtained. Cost assessments should include hardware and software procurements, contracts for consulting and programming services and costs for staff training and in-house activities.

Application considerations concern the ability of the program to perform the job required of it and include specific constraints imposed by the operating procedure at each agency.

These five general categories of criterion recur throughout the evaluation considerations for the various types of software described in this handbook. They are summarized in Figure 2.2.

Technical considerations. The system configuration you are considering may impose some constraints on the software you select.

A **hard disk** should be fully used by your programs. The operating system must support a hard disk. Ideally it is convenient to store programs on the hard disk, but copy protection sometimes prevents this. Provision should be made for security of data stored on the hard disk to protect it from unauthorized access or tampering.

Networked or multi-user systems should be compatible with the software you select. Networking hardware comes with its own system software to provide limited shared use of data. In order to make full use of networking for data sharing the application software must support

	CONSIDERATION	USE	WHAT TO LOOK FOR
TECHNICAL CONSTRAINTS			
	Hard Disk	Efficient use and rapid retrieval of large amounts of data.	Programs which run on an operating system which supports a hard disk.
		Sharing of data by several users.	
	Multi-user System	Sharing of data and programs by several users using different computers in a network.	Programs which run on a multi-user operating system.
			Programs which support multiple users.
	Compatibility with a Peer Agency	Joint development of applications.	Compatible operating systems and programs.
		Shared knowledge and experience between systems.	
SYSTEM CONSIDERATIONS			
	Compatibility	Ability to run programs in a similar environment, reduces confusion, facilitates learning.	Programs that run on the same operating system.
		Exchange of data between programs.	Programs which recognize the same data format on diskettes (e.g. DIF, ASCII, etc.).
	Flexibility	Adaptation of program to the specific practices and needs of the agency.	Built in flexibility in application programs.
		Usefulness of the program to respond to unusual needs.	Distribution of the application program's source code.
	Expansibility	Accommodation of agency growth.	Ample capacity for additional data.
		Ability to accommodate development of increasingly sophisticated microcomputer applications.	May consider support for multi-user or networked system.
			Generic programs which can combine or handle several files at once.
			Generic programs which can themselves be "programmed."

USER CONSIDERATIONS			
	Ease of Use	Encouragement of staff support and initiative in implementing and maintaining the application.	Clear, well written, well organized documentation. Tutorial. Menu driven programs.
	Fit with Agency Practice	Minimal disruption of agency operating procedures in introducing program.	Data requirements consistent with agency practice. Report formats consistent with agency requirements.
COST			
	Reasonable cost	System cost within agency resources.	Reasonable costs for staff training; easy to use programs. Cost for purchase or development reasonable with respect to expected benefits.
APPLICATION CONSIDERATIONS			
	Benefits of application	Reliable performance of desired functions by the program.	Specific to each application.

FIGURE 2.2 Key Considerations in Software Selection.

sharing of data files; very little application software offers this. Multi-user systems require an operating system which supports multiple users and software which will run on this operating system. At present, limited commercial software is available for these systems.

Coordination with other agencies may have suggested constraints on the software you select to maintain compatibility between the systems.

System considerations. Because of the range of interrelated applications, and the organizational complexity of developing a system, compatibility, flexibility, and expansibility are key themes to the selection of software. These concepts ensure that the various parts of your system form a cooperative, flexible whole which can be adapted to your transit agency's present and future needs.

Compatibility is required between selected programs to enable them to be used together, with interchange of data. Generally it means that they should all run on the same operating system. They should also recognize, as much as possible, the same data format on diskettes, so data can be transferred between them. This can be achieved either through the use of "integrated" programs which combine various functions in a single program or through the use of families of programs, usually from the same company, which are designed to be used together.

Flexibility is required to incorporate the inevitable changes that must be made to improve the fit between the application and the organization, and to incorporate changes in procedures and needs. Key elements of a flexible system include a data input process which fits the form in which the data is obtained, report formats which generate reports which suit your present and anticipated needs, and the ability to use the program to perform as many of the data manipulations which you anticipate as possible whether they be routine or occasional.

Generally a trade-off exists between the flexibility of a program and the specificity of its application. Generic programs are extremely flexible, but offer little structure for a specific application, such as inventory. An inventory application program may be easy to install and use but not allow you to specify particular report formats or unusual summaries, if the programmer did not anticipate your needs. The objective then, when considering the application programs, is to look for those which leave options open to the user.

Another aspect of flexibility concerns the availability of "source code." Source code is the set of instructions which make up the program in the language in which it was originally written. The source code can be modified by a programmer to incorporate changes required by the user. Alternatively a program's "object code" may be distributed, which will run, but cannot be changed.

Expansibility will allow the system to incorporate the growth and evolution of the agency, and of its information and data processing needs. If the agency grows the amount of data generated will increase, as will the number of people using the microcomputer. The software selected should have a capacity for data files larger than those you currently use. If you anticipate using a microcomputer to capacity it

may be wise to consider a larger computer, an additional computer, or a networked or multi-user system.

A second form of expansion concerns the development of the microcomputer system within the agency. As early applications are implemented they are likely to suggest more comprehensive applications, and to interest other staff members in their own applications. At this point transfer of data between programs and departments may become interesting, requiring the compatibility discussed above. In addition, more sophisticated applications will require single programs, particularly spreadsheets and database managers, to be able to combine data from several files of data. The more sophisticated applications may also be recorded in "programs" of instructions within the spreadsheet or database manager.

User considerations. Two essential considerations concern the usefulness of the software from the point of view of the agency staff who will actually use it.

Ease of use of the software will have a major impact on the extent to which the system is assimilated in the day-to-day functioning of the agency. An inconvenient program will discourage indifferent users from exploring new applications. Various things contribute to ease of use of a program, including the quality of documentation, learning aids, and the command structure of the program itself.

A good **fit with agency practice** facilitates adoption of microcomputer applications. The most beneficial applications are frequently those which facilitate performance of an existing function without generating trauma by reorganizing the task. Good fit includes making use of data which is available and generating the reports and output which are required.

Cost. The **cost** of the system includes hidden elements such as training, staff or consultant time to install applications, maintenance, and supplies. Beyond the purchase cost of the software, operating costs are involved in implementing and maintaining the system. Some expenses are related to the implementation of the application; these include staff or consultant time to develop and set up the application and to input any background data. Another staff cost concerns training, and includes fees for training, as well as time spent becoming familiar with the application. A coordinator of the microcomputer system will also be required to administer ongoing requirements of the system such as purchasing supplies and coordinating the various applications.

Application considerations. In addition to these general considerations which affect all software to a greater or lesser degree, individual application considerations apply to application programs. The program should actually do what is needed for each application. It should be able to accomodate the specific characteristics of the agency operation, such as work rules, reporting requirements, and maintenance procedures. These considerations are specific to each agency and each application.

In case several similar programs qualify under these criteria it may be necessary to involve other considerations in your selection. For generic programs, comparative evaluations in computer magazines can help to identify the best program for your needs. The application program which best fits your current procedures should be selected.

Step 5: Developing an Implementation Plan

The future success of the system depends significantly on the way in which it is implemented. Care must be taken to develop staff capabilities and support during the process, and to minimize failures. Issues concerning system implementation are discussed in Chapter 8.

Conclusion

While microcomputers are now inexpensive enough to be available to more transit agencies than ever before, they are still not cheap. The cost includes many hidden elements such as staff time developing applications, costs of staff training and gaining experience, and procedural changes in the organization. In preparation for this investment, it is worth putting some effort into planning a system which will benefit the agency.

The process described here can rarely be followed step by step, particularly when a learning process is taking place simultaneously. However it does provide some general guidelines for designing a microcomputer system, and should result in the following products:

1. A realistic idea of the roles a microcomputer might play.
2. Early support and interest from the staff.
3. A list of applications identifying high benefit, low risk, and straightforward applications to be implemented first.
4. Ideas as to future directions the system might take, which should be kept open as options in selecting a system.

CHAPTER 3

GENERIC SOFTWARE

The term generic software refers to a number of programs which are designed as general purpose tools to be applied in any number of different situations. The major examples of generic programs are:

-spreadsheets
-file or database managers
-word processors

These programs are extremely versatile, and give the microcomputer user great control and flexibility in using them. Because of their ease of learning and usefulness, they have been at least as important in the rapid adoption of microcomputer technology as the technical development of the computer itself.

Spreadsheets

Of the many programs available on microcomputers, the electronic spreadsheet has probably had the greatest impact in making the technology a practical tool with visible benefits to the user. The basic idea of an electronic spreadsheet, first marketed as the venerable VisiCalc, has been enhanced and incorporated in innumerable later programs.

Function

The electronic spreadsheet is a large table with rows and columns of cells. The user may place a number, a label, or a formula in each cell. The formulas may include values from other cells, and it is this which makes the spreadsheet so effective. When a value which is used in other formulas is changed, the results of the dependent formulas are automatically recalculated.

Figure 3.1 shows a simple example of a spreadsheet. In this case the fuel mileage for each fleet is known, and the user wants to know the fuel requirement for various projected amounts of mileage. When the spreadsheet is set up, the formula "B3/C3" is entered in cell D3. From then on the spreadsheet will display the result of the calculation in cell D3, in this case 24,000 divided by 3.8 or 6316. If the projected mileage in cell B3 is changed, the result in D3 will change automatically.

This fundamental concept allows computational problems to be displayed visually as steps in a table, making the problem easier to

	A	B	C	D	E	F	G	H
1	FLEET	MILES	FUEL	FUEL				
2			MILEAGE	(GALLONS)				
3	40 FT.	24000	3.8	6316				
4	MINI-BUS	8600	6.8	1265				
5	VAN	5700	11.3	504				
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

CAPS

Figure 3.1 Spreadsheet Example

understand and resolve. The spreadsheets provide numerous commands, which help the user to set up the application and create a table which is understandable and suitable for presentation. For example, the commands allow the user to copy a formula from one cell to a number of others, or to set the format of numbers displayed as integers, real numbers with two decimal places, or even dollars. Functions such as "average," "maximum," or even "net present value" are also provided for use in the formulas.

The applications for this capability are virtually unlimited. It permits rapid calculation of outcomes for a range of input values by a sophisticated process of trial and error. Tables of interrelated values, such as budgets and performance measures, may be rapidly changed or updated. Small amounts of data may be organized and manipulated. As a result, spreadsheets have become the most used type of microcomputer software.

What to Look For

Spreadsheets are now available in many different packages. While the key to their usefulness is the concept, the enhancements provided in the various programs make them more or less powerful and flexible. As with any piece of software, they should be considered as part of the system of programs which will be used together. Because of the many applications of these programs, it is a good idea to think broadly about possible future uses and keep options open.

The following characteristics of spreadsheets should be considered in selecting a package:

1. **Matrix size.** A larger matrix gives one more flexibility in setting up complex applications. Most spreadsheets now available on microcomputers with a reasonable amount of memory provide ample working space. A minimal size would be 50 columns by 200 rows.

2. **Formula length.** Formulas can very easily become long when functions are being used. Formula length should not be limited by column width; it should be possible to put a formula over 9 characters long in a column 9 characters wide.

3. **Modifications to the spreadsheet.** Under certain circumstances one would like to modify a spreadsheet by adding or deleting columns or rows. It is important that the package automatically adjust the coordinates of values in formulas when a new row or column is added or deleted.

4. **Report appearance.** Features such as variable column widths and optional titles allow spreadsheet printout to be sufficiently presentable for many reporting and presentation needs.

5. **Speed.** Most spreadsheet programs automatically recalculate all the formulas every time a change is made. Speed is an important consideration, since spreadsheets are interactive, and you will be

sitting idle while it does all the thinking. The recalculation will slow down as the matrix becomes larger. The best way to evaluate this is to spend some time working with those you are considering seriously, with a large spreadsheet, perhaps 100 rows by 20 columns. Notice the time it takes to recalculate the spreadsheet. This delay can be reduced if automatic recalculation can be turned off, so the formula will recalculate only on command. Compare notes with other users of the program.

6. **Transfer of data between spreadsheets.** It is often desirable to transfer data generated by one spreadsheet to another. For example, when consolidating budgets generated for separate projects or divisions onto a summary budget it is desirable to move the budget totals from each division onto the summary template without having to re-enter all the figures manually. Some packages allow one to transfer selected portions of one spreadsheet onto another.

7. **Functions and statistical capabilities.** Functions, which are used as part of the formulas, simplify frequently performed tasks such as totaling values in a column, averaging a series of numbers, or finding the square root of a value. The range of functions available on a specific package may affect its flexibility to perform a variety of tasks. Most packages include the standard mathematical functions, including logs, square roots, and trigonometric functions. If the spreadsheet will be used for financial purposes, financial functions such as net present value may be helpful. For planning and forecasting, statistical functions (such as minimum, maximum, average, and standard deviation) are helpful. Regressions and moving averages are also available in some packages and may be valuable for ridership or cost forecasting. Many programs also offer logical functions, such as IF, TRUE, FALSE, AND, and OR, which have applications in advanced use of spreadsheets. A function which allows you to look up data from a master table in the spreadsheet is very handy.

8. **Program development.** A frequent user of a spreadsheet will find that there are some sequences of commands which are used repeatedly, or which are somewhat complicated and hard to remember. Some spreadsheets allow the user to specify and name this sequence to be executed together. This is sometimes called a macro. The sequence of commands recorded in this way can be invoked by using the assigned name. This capability is particularly valuable for routine tasks, such as updating route performance data by incorporating new data.

9. **Protected cells.** When several users may be using the same spreadsheet, it may be desirable to protect data or formulas by locking selected cells, or by limiting the type of data that may be entered in them.

File/Database Managers

While spreadsheets have had the greatest short-term impact in spurring the acceptance of microcomputers, file and database managers have the greatest potential for making the technical capabilities of micros useful to transit managers. These programs are still in a process of evolution toward a product which is flexible and versatile, while remaining easy enough to learn and use so that it can be implemented with little or no assistance from a skilled programmer. The term "database manager" will be used throughout this section, as file managers are actually a limited form of database manager.

Function

A "database" is a large, continuously updated body of information, which is organized so that it can be usefully extracted, analyzed, and summarized. Numerous databases can be found in the file cabinets in any transit operation. Maintenance records are kept on work orders, vehicle histories, fluids consumption and inventory. Personnel records on attendance, discipline, and personal data are maintained on an ongoing basis. In operations, schedules, pull out sheets, run guides, paddles, and time reports must be updated regularly. Accounting and financial record keeping can also be considered a large database operation.

Database managers make use of the computer's ability to store and manipulate large amounts of information quickly. The purpose of the database manager is to structure the information in such a way that it becomes accessible through the computer, and to provide powerful commands to perform data manipulations, such as sorting or finding data, in one step.

The heart of a database system is the way the information is structured. Microcomputer databases are structured as a set of files (or relations), each consisting of records, which are in turn made up of fields (or attributes). A file is analagous to a paper file containing, for example, vehicle histories for a fleet, or personal data for all employees, and can be imagined as a large table. Files are the units in which data is stored on disks. Each file is composed of a number of records, each containing data for one bus or one employee, and all structured in exactly the same way, like a preprinted form. Each piece of information in the record, such as the date of purchase of the vehicle, or telephone number of the employee, is called a field. Figure 3.2 illustrates the relationship between these elements.

The key to database implementation is defining the structure and interrelationship of the data files. This requires a thorough understanding of the means of collecting and uses of the data, manipulations which might be desired, and the capabilities of the program being used. A well organized manual record-keeping system may be transferred fairly directly to a database manager. Substantial procedural changes may be required in a system which currently maintains disorganized or incomplete information.

Record Number					
	Field				
00082	William Grimm	345	full-time	234 Keyes Avenue	Springdale
00083	William Martin	459	FULL-time	234 Beachwood Ave.	Summitt
00084	William Purcell	556	Full-time	93 Summit Avenue	Altamont
00085	Charles Nichols	121	full-time	102 Waverly Road	Amherst
00086	Geraldine Manning	188	full-time	234 Peck Road	Monroe
00087	Linda Eckert	187	Full-time	454 Coronet St.	RExford
00088	Linda Johnson	540	full-time	343 Edward St.	Brunswick
00089	Lucille Graham	345	Full-time	89 Sidney Road	Cardiff
00090	Virginia Deitz	203	full-time	234 Whitehall Rd.	Earlton
00091	Donald Jones	451	full-time	454 Lark Street	Riverside
00092	George Mitchell	342	full-time	89 Elm Avenue	Clinton
00093	William Johnson	454	full-time	902 Wendell Ave.	Springwood

Record

Figure 3.2 Database Example: Employee Data File

The potential benefits of database management are enormous. The time required to perform routine summaries of information, or locate a particular piece of information can be reduced. This makes it feasible to summarize the data in ways which can help decision-makers, but which were not possible before due to the time required. This capability may increase the amount of data available to managers in planning and decision-making.

Because of the complexity of database management, it is possible that you may find it effective to hire a programmer to work with you in implementing a database system. Not only the technical aspects of using the program, but also the issues concerned with designing the files and interrelationships between them in the context of day-to-day transit operations, may benefit from the experience and perspective of an outsider.

What to Look For

Database management capabilities are available in a spectrum of programs. At one end of the spectrum are the "file managers", which are very limited because they can usually only manipulate one file at a time, but which are very easy to learn and use and are relatively inexpensive. On the other end of the spectrum are programs structured very much like high-level programming languages, which are very versatile in their capabilities but harder to learn and use. In general the more complex programs can also easily perform the simpler tasks accomplished by file managers.

File managers perform a valuable function in limited tasks which do not require multiple files or large amounts of data. They also provide a comfortable introduction to many concepts of database management. However, it is important to recognize their constraints from the outset. If an application is likely to become more complex and require coordination of different files, either start with a database manager, or plan to upgrade in the future.

A major distinction between database management programs concerns "menu-driven" and "command driven" software. Menu-driven programs offer a menu of commands to choose from at each step, and prompt the user for information required. Figure 3.3 shows the menu from a simple file management program. The user does not need to memorize a list of commands, but only know what each of the choices will do. "Help" information is often available for reference during use. Command driven programs, on the other hand, offer little help to the user, who must know the commands and the format of additional information required. Command-driven programs may offer more flexibility for the advanced or regular user, because they are not constrained by the menus, however they are considerably more difficult for the beginner or casual user to learn.

A general rule in selecting a database manager is to keep options open for future uses of the program. This implies that it is desirable to look for capabilities in the program for which you may not have iden-

```
FILE:CLIENTS

                    (F1)   ADD a record
                    (F2)   MODify  a record
                    (F3)   DELete  a record
                    (F4)   DISplay a record
                    (F5)   FINd a record
                    (F6)   LISt the records
                    (F7)   SORt the index
                    (F8)   see the record LAYout
                    (F9)   alter a Field NAMe
                    (F10)  END

Your Command:___
```

Figure 3.3 Menu Example

tified an immediate use, but which will allow your database applications to grow in future. If you hire a consultant or programmer to help implement a database system, some of the capabilities of the program may be used by your programmer rather than by transit agency staff.

Key characteristics to look for in considering programs include:

1. **Ability to work simultaneously with several files.** This characteristic of database managers is what generally distinguishes them from the less expensive file managers. In virtually every database application it is desirable to be able to transfer or link data from different files. Examples of this would include work order and inventory data, client records and daily scheduling records (for specialized, elderly and handicapped service), etc. Even if you intend to start using a database for manipulation of single files, it is very likely that you will want to expand the application as you become more comfortable with the system. The capability to manipulate several files is important to retain the option of integrating files in the future.

   Several types of operations make use of this capacity. Files can be joined or linked on the basis of some common piece of data. For example, service reports might be linked with vehicle history information by comparing vehicle ID numbers. Data fields from one file's records might be compared with, or used in a mathematical formula with data from a second file's records. It may be desirable to look up data from a work order in one file while working with another file containing vehicle histories.

2. **Ability to update file structures.** As a natural part of expanding a database application, or as a result of changing data requirements in the agency, it may be necessary to change the structure of a data file; for example, information for a new employee incentive program must be added to each employee's record. The program should allow the user to add new data fields or change the characteristics (length, data type, etc.) of the fields, without having to reenter all the existing data.

3. **Use of direct commands.** It should be possible for the transit agency staff to undertake simple procedures, or tasks which will rarely be repeated, step by step using easily learned commands, preferably assisted by a menu of commands. Examples of this type include finding inventory information or a particular part, or listing all employees with family health insurance.

4. **Use of program or command files.** It is desirable to be able to record the commands required to perform certain tasks in a program or command file which can be executed with a single command. This capacity allows programs to be written to perform complex or frequently repeated tasks. Programs may also be written to allow staff who are not familiar with the database management program to use it for routine data analysis; such a program could allow maintenance staff to input work order data or check a vehicle history.

5. **Speed.** One of the most time consuming aspects of database management is reading and writing large amounts of data from mass storage, such as diskettes and hard disks. The large amounts of data manipulation involved in sorting and processing data files may also be time consuming. This time will be perceptible to the user for virtually all database managers with large data files, but some may be faster than others. Check to make sure that a program you are considering will not take all night to read and sort a reasonable-sized file. Magazine reviews or other users' experiences will help to judge this.

Word Processors

A third type of program which will find numerous applications in the transit agency is a word processor. These programs allow text to be entered on the microcomputer, changed and revised, and stored on adiskette for retrieval as required.

Function

Word processors give the user two different types of flexibility in writing. First, a text editor records typed material on a diskette. Commands allow the user to make corrections, insert or delete text, rearrange material and make copies or different versions of the text. Text can easily be underlined, centered, indented, and so on. Second, a text formatter provides numerous options for printing the document, such as line spacing, page length, margin width, headers, and page numbering.

The use of word processors is highly contageous and addictive. It saves clerical staff the need to completely retype a letter to correct typos or incorporate an editorial change. Many managers find that they can draft and finalize correspondence and memos faster on a word processor than they can write the draft and proof first copy. It is a good idea to decide early whether word processing is a desirable use for your microcomputer, because it could dominate the microcomputer's time.

Some applications of word processors are particularly suitable for transit agencies. Boilerplate for specifications can be rapidly updated for each application without having to retype from scratch. Background material for grant applications and planning documents can be adapted easily to each requirement. Likewise, contracts may be easily revised. Time savings can be realized in revising paddles and operating paperwork to incorporate a schedule change.

Word processors have facilitated bulk mailings to lists of addresses. Lists of subscribers, clients, pass distributors, or employees may be incorporated in a standard letter so that each is individually addressed. Appropriate data, such as a license expiration date or pass type may be inserted in the letter's text. This capacity greatly increases the agency's flexibility in communicating with the community it serves.

What to Look For

Word processing is one of the most competitive of the microcomputer applications. Numerous programs of varying qualities and with differing orientations are on the market. It is helpful to define the type of material you will be producing on your word processor before considering the programs available. Considerations such as length of document, whether you will use footnotes, unusual characters, etc. will help to sort out the programs which will meet your needs.

Characteristics to look for in a word processor include:

1. **Command format.** Many commands, such as indentation, underlining, or centering are required frequently in the course of typing. It is preferable that commands be called with a single key stroke, rather than a series of key strokes. The feasibility of single keystroke commands depends on the microcomputer and keyboard being used.

2. **Printing options.** Many word processors include options for editing the appearance of text printout. The user may underline, boldface or center selected text, or indent entire paragraphs. Ideally these options should be displayed on the screen as they will be printed, although some programs display a code letter on the monitor instead.

3. **Moving, copying, and revising text.** Several features help to edit long documents. Sections of text should be able to be moved or copied from one location to another. A split screen feature adds to the power of this by allowing two documents to be viewed simultaneously, and text to be copied from one to the other. Text revisions are also facilitated by search and replace functions, which identify all locations that specified words are used, allowing the user to make changes as required. These features should be easy enough to use that they do not inhibit their use.

4. **Printing formats.** Margin widths, page length, and line spacing should be able to be changed by the user. Headers and footers are also very helpful in labeling and numbering pages.

5. **Report organization.** Writing extended technical reports can be helped by features which automatically place footnotes on the appropriate page, and which store and sort key words for a table of contents or index.

6. **Ability to handle mailing lists.** If your agency handles mail-out surveys, or mailings to clients or employees, the program should support this. It should be able to print mailing labels on various types of forms and incorporate the address, name of addressee, and a small amount of text in the letter.

7. **Ability to handle tables.** One of the most worthwhile applications of word processing in small transit operations may be for revising schedules and paddles. For this application the word processor

should be capable of manipulating tables, including inserting and deleting rows and columns. Columns of figures should be aligned by decimal point, if desired. It should also be possible to edit and view tables up to 200 characters wide.

8. **Print buffer.** Does the word processor provide a mechanism for printing the document you just completed while you go on with another task? If not, you may want to purchase a print buffer or spooler, which will perform the same function.

Other Generic Software

Graphics

Graphics capabilities are included in many generic packages or families of programs. They allow the user to rapidly generate graphs and charts from data in a spreadsheet or data file manager. Often graphic presentation conveys clearly the trends and patterns which the numbers represent, and provides a valuable tool for board presentations and public information.

When using a graphics package the user assembles the illustration in a series of steps. The type of graph is selected, followed by the particular set of data to be portrayed. Labels can be selected for the axes or legends, located on the graph itself or provided as titles to the entire graph. Colors or tints and line patterns may be selected for the graph. At any point the graph may be viewed prior to adding or deleting information.

The quality of the printed document produced depends on the program being used and the computer hardware. A graphics board may be required for your monitor to be capable of displaying graphics at all. A dot matrix printer, thermal printer, or ink jet printer is required to produce graphic output.

Statistics

Statistical analysis on main-frame computers has been used frequently in the transit industry for analysis of market research and ridership surveys. Until recently, statistical analysis on microcomputers was limited by the amount of memory and the slow speed of the equipment available. However, with the advent of hard disks, increasingly large amounts of internal memory and faster processing, reasonably powerful statistical programs are becoming available. Crosstabs, regressions, frequencies, and calculation of various summary statistics may be undertaken for fairly large samples. Powerful statistical analysis of samples on many microcomputers is rapidly becoming realistic.

Current technical constraints on the amount of internal memory have resulted in two approaches to the manipulation of large amounts of data. Some programs require the entire data file to be loaded into internal

memory. This strategy allows rapid calculation, since all data is internal, but limits the amount of material which can be processed to the available space. Alternatively, data can be read from, and written to, disk as it is required for analysis and calculations. This process slows down the operation considerably, as reading and writing are time-consuming processes; however, much larger files can be accommodated in this way.

The Role of Generic Software

Generic tools, because of their range of applications, require more active participation by the user than programs designed for a particular task. The spreadsheet needs to be set up for the particular application, or the structure of database files must be defined. To make this feasible for the large number of users who have no prior computer experience, these programs have been designed to be easy to learn and use. For example, most programs include a tutorial, a structured introductory exercise, which teaches the user enough to produce useful results in several hours and demonstrates the capabilities of the program. They also provide ongoing assistance to the user in the form of "menus," from which to select commands and "Help" documentation, which displays additional information on the screen when the user requests it while using the program.

In spite of the ease of use, many of these programs allow quite sophisticated application by experienced users. In some cases, "programs" for particular tasks can be written and stored, to be called by name when they are to be performed.

Making effective use of generic software does require some time and effort to plan and set up the particular application. Many applications may be transfered more or less directly from manual processes already being used. Applications of generic programs must be set up by someone who thoroughly understands the task being undertaken, and can creatively adapt it to the capabilities of the programs; however, once set up they can be used by other individuals with a less active understanding of the program and the application.

Many generic applications are now available in "integrated" programs in which a spreadsheet, database manager, word processor, and possibly other functions are included in one package. Other applications are available in families of programs, which are designed to be used together. In general, this trend of integration overcomes a number of the problems with compatibility which may be encountered when each application is purchased separately. It also may offer significant time savings to the user in switching from one application to another. This is valuable when, for example, a user might take data from a database file and manipulate it in a spreadsheet, or incorporate a table from a spreadsheet in a report. Integrated applications and families of programs usually share the same command structures, making it easier and less confusing to switch between them. The major drawback to look for in purchasing an integrated package or family of programs is that the various modules or components of the program may not all be equally

powerful, or may not meet all your needs. For example, a file manager in an integrated package may not offer the range of commands or size of files which might be provided with an independent file manager. Each module should be compared to the capabilities of non-integrated programs to ensure that any difference in quality will not offset the benefits of integration.

What to Look For in Generic Software

In addition to the specific considerations listed above for each type of program, a number of general guidelines apply to all generic software. The following criteria are derived from the considerations for selecting software, summarized in Figure 2.2:

1. **Hard disk support** (if required). If your system will include a hard disk the program should be able to make use of this storage. It should run on an operating system which will support the hard disk. It should be able to read from and write to the hard disk. Security mechanisms should be available so that data stored on the hard disk is protected from unauthorized access. Ideally, the program itself may be copied to and used from the hard disk; however, copy protection used by the software distributers to protect their product may preclude this.

2. **Multi-user support** (if required). If the program is to be run on a multi-user software system it must be available for use on a multi-user operating system.

3. **Compatibility with peer systems.** Applications of generic software, because they are easily understood and modified, are particularly well suited for exchange between peer transit systems. If application development on a database manager is contemplated, joint development with another agency may be feasible and economical. For these reasons it may be desirable to select products used by a neighboring system with similar characteristics to yours.

4. **Common operating system.** To minimize confusion and provide compatibility between programs, all programs should run on the same operating system. Selection of an integrated package or family of programs will provide this.

5. **Transfer of data files between programs.** The ability to transfer data between the various pieces of software in your system is very important. Names and addresses stored by your file manager may be needed for a mailing list on your word processor. Data from the file manager may be transfered to a spreadsheet for analysis, or a table from a spreadsheet may be incorporated in a report on the word processor.

   Many generic programs provide the means to do this, by translating data to or from a format which can be read by other programs. Standard file formats for this type of transfer include the DIF for-

mat and ASCII text files. Some packages provide specific transfer capability to or from selected other programs. Selection of an integrated package or family of programs ensures transferability of data.

6. **Ease of use.** Generic programs are usually the first piece of software many people use on a microcomputer. Spreadsheets in particular, are frequently used as a scratch pad, for brief, one time applications. As a result it is important that they be easy to learn and to use. The sophisticated features of the program should not interfere with use for basic applications. A program which is already familiar to users in the agency, or even the industry, will contribute more rapidly to accomplishment of worthwhile results on the micro.

   Menus of commands can help make a program easy to learn and use. Commands should be able to be called with a minimal number of keystrokes.

7. **Quality documentation.** Good documentation may make a program easy to learn and use; poor documentation may make it impossible. Look for a well organized manual with a clear table of contents and index, a step-by-step tutorial covering the capabilities of the program, with written text that you can understand, with examples. The manual should lie open on a table (loose leaf or coil bound for example). It is helpful if a small card or booklet summarizing commands for reference is provided.

Conclusion

Of the three major types of generic programs, spreadsheets and word processors are fairly mature. Most of the major improvements have been thought of and copied and the differences between programs are likely to be fairly superficial, or minor differences in emphasis. Database managers, however, are fundamentally more complex and are still being improved in more fundamental ways. Statistical analysis is only just becoming feasible on microcomputers. Figure 3.4 summarizes the various factors to consider when evaluating the first three of these programs.

Part II of this handbook documents several transit applications of generic software, primarily spreadsheets.

APPLICATION	WHAT TO LOOK FOR
ALL GENERIC SOFTWARE	Hard disk support (if required)
	Multi-user support (if required)
	Compatibility with peer systems
	Common operating system
	Transfer of data between programs: DIF, ASCII, or other format
	Ease of Use: menus or prompts
	Quality documentation: well organized, tutorial
SPREADSHEETS	Matrix size
	Formula Length
	Modifications to spreadsheet: insert and delete rows and columns
	Report appearance: column width, headings
	Speed: manual recalculation
	Transfer of data between spreadsheets
	Functions and statistical capabilities: financial, logical, statistical
	Program development, macros
	Protected cells
DATABASE MANAGERS	Ability to work with several files
	Ability to update file structure
	Use of program or command files
	Speed
WORD PROCESSORS	Command format
	Printing options
	Moving, copying, and revising: split screen, search and replace
	Printing formats: margins, headers
	Report organization: footnotes, contents
	Handling of mailing lists: label printing, letter addressing
	Handling of tables: column and row insert and delete
	Print buffer

Figure 3.4 What to Look For in Generic Software: Summary

CHAPTER 4

APPLICATION SOFTWARE

This chapter discusses microcomputer programs written to accomplish particular tasks in transit management. The sections describe general considerations in selecting application software, and sources of application programs. The availability of programs for various transit applications is described.

The difference between generic and application software is somewhat analagous to the difference between a hand metal cutter and an industrial punch. The metal cutter can do the same job as the punch, though less efficiently, as well as numerous other jobs. The user must be skilled in the use of the tool, but can then use it with great flexibility. The punch does one job as determined by a pattern, and may do it very well.

There are three two types of benefits which may be obtained from the purchase of transit application programs. Many of the applications, such as maintenance management, inventory, and ridership analysis, are basically database management applications of existing methods. The computer is programmed to do the same steps which are presently done by hand. In these cases one benefits from the developer's programming experience and the thought put into the development of the application. Others, such as runcutters and planning tools, incorporate mathematical methods in an easily usable tool. Such products may incorporate the developer's expertise in the particular management function, allowing the user of the program to benefit from techniques they would not otherwise use. Finally, some make use of innovative technology, such as the use of portable devices for data collection.

Sources of Application Programs

There are four sources of transit software.

1. UMTA and other public agencies are sponsoring the development of a number of programs which will be in the **public domain**.

2. Some **commercial, general purpose programs**, designed for specific business applications, such as accounting or inventory, may be applicable to transit operations.

3. A number of programmers and consultants are developing **proprietary applications** for sale.

4. It is also possible to have **custom programs** developed for your purpose.

Public Domain Programs

UMTA has sponsored the development, testing, and distribution of a number of transit application programs. These programs have been, or are being, developed by transit agency staff and/or consultants. After development they are reviewed and tested before being made available to other agencies. New releases are announced in "TIME Capsule" and distributed, for the cost of reproduction, through the TIME Support Center (see Appendix for reference).

The first programs of this type, including two transit trip schedulers, a route performance and cost analysis program, a strategic planning model, and some programming utilities, were developed for Apple microcomputers in the programming language PASCAL on the UCSD p-System operating system. (See Chapter 5 for discussion of operating systems.) Due to the increasing popularity of the IBM microcomputers and compatible machines, these programs are now being converted to run on IBMs. A wage and benefit forecasting model for the IBM with the NCI p-system is also available.

A group of demonstrations using database managers to build timekeeping, parts inventory and client record keeping systems is also being funded. These demonstrations will be distributed and will be documented as models to provide guidance for development of similar programs by transit operators. The demonstrations will provide a point of departure for transit management, with the help of a local programmer and a database management program, to develop a system tailored to the local system's needs.

In addition to UMTA sponsored application programs, other application development sponsored by public agencies may be in the public domain. Theoretically these programs could be transplanted to other agencies. Actually many complications exist. The developing agency is not in the software distribution business and does not have resources to support the transfer of their program to other operations. It is also likely that modifications would be required. Unless the modifications are minor and the application is written in an easy language to modify, this could be a major undertaking.

"Off-the-Shelf" General Purpose Programs

A limited number of commercially distributed application programs have roles in the transit industry. The accounting and inventory functions are particularly suitable for automation using existing software. However, most of these packages were developed for the largest possible markets, such as small businesses and retail outlets. For this reason they may not be appropriate for transit operations, with their complex record keeping and funding structures. These packages should be reviewed in detail to assure that they will perform as required.

Off-the-shelf programs can be purchased from retail outlets or mail order houses. Retail outlets may give you the opportunity to try out the product in the store and see what it is you are purchasing. At the

same time their inventory is limited, so if you do not find the product that you are looking for, do not give up. If you know what you want, mail order houses offer the more popular off-the-shelf packages at significantly reduced prices. In either case, users of the program, program manuals, and magazine reviews are a better source of information than sales staff who may not be familiar with the products they are selling, and are biased toward the specific programs they distribute.

Proprietary Transit Programs

Software is becoming increasingly available for a number of transit management functions. These programs are developed as commercial ventures by programmers, consultants, or academic staff. Distributors of proprietary software may provide a demonstration diskette if you are considering purchasing their program. This diskette, for a relatively low cost (often under $20), provides a limited version of the program, and sometimes a sample session to demonstrate its use. Review of the demonstrator can be very valuable in identifying qualities to look for in the general type of software, as well as becoming introduced to the specific program.

Proprietary products may be marketed in several ways. Occasionally programs may be provided with documentation for installation by the purchaser. Installation may include copying portions of the operating system onto the program diskette, making adjustments for the specific hardware being used, and setting up an initial database. Normally some involvement by the distributor is required to install the program, and may include setting up data input structures, report formats, etc. Some products are marketed as turn-key systems, in which the microcomputer equipment, software, and limited consulting services for installation and training are provided as a package.

Because of the relatively small market for such specialized products, the cost of these programs is high ($5,000-$20,000). These programs must be designed to be flexible in order to be suited for a large number of agencies. As a result they may not provide a perfect fit with the needs and operating practices of each agency. However, the disadvantages inherent in purchasing such a package must be compared with the true cost of developing a complex application in house.

An additional consideration which applies when purchasing proprietary software is the amount of support which will be available. These programs have probably had less use, and are more specific to a particular agency, than mass marketed programs. As a result they may have more problems. Will the distributor warranty the product against errors ("bugs")? Documentation should be thorough and usable. (This is particularly important for this type of purchase, since the distributor is probably more interested in the problem and program than in public relations.) How much training will the distributor provide? What kind of response will you get when you call with a problem? Is the distributor stable and likely to stay in business? Other users of the program will be able to help you evaluate the supportiveness of the distributor.

Custom Programs

If none of the above products fill the need, it may be necessary to have a program written for the purpose. This is not to be taken lightly. A custom program is likely to be up to 10 times as expensive as packaged software and often takes two or three times as long as expected to complete.

If you decide to hire a programmer for software development, prepare specific requirements as to what data will be input, in what form, by whom and when. Also specify the reports that will be required. Once these have been established, consider them fixed, as later changes would increase the time required for and cost of the program. Have the programmer provide a detailed description of the program, including mock-ups of input screens, reports and command menus, for your approval before the actual programming begins. Fix the timetable and establish penalties for over-run. Make explicit the amount and type of documentation and training you require. Include in the contract debugging (identification and correction of errors) and a trial implementation period before accepting the product.

Application Areas

This section summarizes the areas where application software is in use in the transit industry within the three management categories of operations, planning, and finance and accounting.

Operations

Application programs are available for two functions within the operations area: (1) scheduling, and (2) fleet maintenance and inventory.

Scheduling and runcutting. The program RUCUS, running on mainframe computers, has been one of the more visible applications of automation in the transit industry in the past. Scheduling and runcutting is an extremely laborious process, which is well suited to the editing and repetition capabilities of computers.

Although not yet capable of handling the entire RUCUS process, microcomputers can be valuable in facilitating individual parts of the process. Several programs are available to assist with this task. Some perform only portions of the scheduling, blocking, runcutting, and editing process while others combine one or more functions. A public domain scheduler, available from the TIME Support Center, builds and edits blocks from starting times and travel time information, and calculates summary statistics. The output from this program can be edited using a text editor or word processing program to generate paddles or public timetables. A simple scheduler using a spreadsheet program is illustrated in Chapter 11. These programs cut down the time required to fill out the time points in schedules, and reduce the effort involved in considering several scheduling alternatives.

Proprietary runcutters are available. Block or train information and runcutting constraints are used as input to these programs which generate runs. The runcutting process may be either automatic or interactive, as desired. Interactive use allows the user to specify runs to cut, while the computer performs the mechanics of keeping track of unassigned work and statistics. Automation of runcutting is most valuable in a system too large for the scheduler to be thoroughly familiar with all the schedules in the system.

Fleet maintenance. Maintenance management is an application where microcomputers may have a significant impact on transit management. An enormous amount of information is generated during routine maintenance functions, which has not in the past been available to decision-makers in a usable form.

Maintenance management is primarily a database management problem, where the objective is to make the data accessible to managers and staff. More complete routine reporting allows the manager to monitor maintenance performance. Special queries can assist management in one-time situations, such as assessing the performance of a particular part, or establishing preventive maintenance intervals for a system. Having data on each vehicle and past work readily available also helps maintenance staff in diagnosing and correcting problems rapidly. Repeat failures, for example, can be identified quickly.

Several components may be included in a maintenance management system including vehicle histories, servicing or fuel ticket records, repair or work orders, and parts inventory. The proprietary systems on the market include some or all of these. Reports generated include preventive maintenance schedules, exception reports, maintenance histories for a particular vehicle, and inventory status reports.

Some proprietary programs are written in database management programs/languages. Due to the many interrelationships between different data files in maintenance management, and the sheer amount of data, a database manager capable of manipulating more than one file at a time is essential for this purpose, even in fairly small properties.

An issue which applies particularly to maintenance management systems concerns the quality of data which is input. Data may be input by maintenance staff. It is desirable for maintenance staff to be involved with the system, so that they are aware of the benefits which they get from it; however, when data is input directly the likelihood of errors and incorrect entries may increase. For this reason "error trapping," which provides checks on data input, is very important. An input item is compared against the range of acceptable values for that piece of data, and a message is displayed if it is not acceptable. More control over data input is provided if data from paper records is reviewed and input by office staff. However this procedure distances the system from the maintenance staff and may reduce its usefulness.

Planning

Application programs are available which may contribute to planning in three areas: (1) on-off count analysis, (2) route performance monitoring, and (3) service planning and long-range planning.

In addition to the application programs, spreadsheets are used extensively for planning. They are particularly valuable for monitoring route-level performance measures, and for estimating costs of planned service. Examples of other applications are documented in Part II of this handbook.

On-off count analysis. Application programs are in use which make use of hand held data collection devices resembling hand held calculators for ridership surveys. The data collected is transferred to a microcomputer, and is summarized in predefined reports. A major advantage to this strategy is that data is input directly at the time of collection, and need not be input later by office staff.

Route performance monitoring. The public domain route performance and cost analysis program available from the TIME Support Center produces summaries of ridership and cost of service by route. A similar analysis can be done on a spreadsheet, illustrated in Part II of this handbook.

Service planning and long-range planning. Several service planning tools have been developed which incorporate demand forecasting techniques not used in current manual methods. Two of these are available from the TIME Support Center. TOPS is a short-range planning tool which predicts route-level changes in ridership and cost due to changes in fare, number of stops, frequency of service, and running time. FRACAS is a long-range or strategic planning tool which can be used to explore trade-offs between route structures, fares, and headways, given various input concerning the agency's operating objectives and environment.

Financial Forecasting and Accounting

Application programs are available for (1) forecasting labor-related costs and (2) accounting. Spreadsheets are also extensively used in this area, and are discussed in Part II.

Forecasting labor-related costs. One application program of relevance in this area is UBUCKS, which is being developed under UMTA sponsorship. This program projects various labor wage and benefit costs and takes into account the amount of service offered, unscheduled pay hours and COLA provisions.

Accounting. Accounting is an application which would appear to be a very appropriate microcomputer application due to the methodical and repetitious nature of the tasks and the amount of numerical calculations. On the other hand, it is a sensitive area, because of the importance of accuracy and correctness. For this reason system

implementation should be handled carefully to avoid transitional problems.

A number of accounting packages are on the market due to the essential nature of the accounting function for all businesses. Because they are designed for use by small private businesses, the key consideration in selecting one is whether it can accommodate the particular requirements of the transit industry.

Most accounting packages consist of five elements which are designed to be used together, but which can be purchased as separate modules:

-general ledger
-accounts payable
-accounts receivable
-payroll
-inventory

A change or correction in one module should be automatically incorporated when it affects the other modules.

The modules of most use to the typical transit agency are general ledger and accounts payable. Accounts receivable may be required in an agency with extensive pass sales or charter work. The payroll module might need to be revised if an exception-based payroll system is in use; many agencies using a service agency may gain little advantage from moving the process in-house while becoming responsible for producing the paychecks punctually. Finally, many inventory modules are designed for retail inventory rather than stockroom control; for example, they may not incorporate reordering thresholds, nor multiple suppliers.

The standard reporting required by Section 15 has some impact on program selection. Can the program use 10 digit account codes? Can reports be formatted to fulfill the Section 15 requirements?

A second consideration in selecting an accounting package concerns the amount of flexiblity. Can you reformat reports to your own requirements? If not will the supplier make modifications for you? If the program is written in a database management language it may facilitate minor changes.

What to Look For in Application Programs

Selection of application software is complicated by the fact that most of it has been developed for a specific microcomputer, operating system combination. The mass market for generic software encourages program developers to make their product available for a large number of common microcomputers and operating systems. The motivation to adapt transit application programs for the various microcomputers is less strong. Many products are designed to be applied in a particular agency's setting, or to be sold with or for a particular machine.

The best source of information on a specific piece of transit application software is undoubtedly a transit property which has been using the program. APTA and state transit association meetings provide a valuable forum for exchange of experiences concerning microcomputer applications. A list of applications under development and available is provided in the US Department of Transportation's Software and Source Book, (see Appendix) which is updated periodically. The staff of the TIME Support Center may also be able to provide general information and references for various transit applications.

A number of considerations are common to application programs in any transit function. These are based on the concepts of compatibility, flexibility, expansibility, and cost, discussed in Chapter 2. Additional technical considerations are discussed for each application area below. Working with the developer of proprietary or custom programs may offer more flexibility in satisfying these objectives than can be obtained with commercial packages.

1. **Transferability of data.** Although the application programs generally provide a more self-contained system than generic programs, there may still be key points where it is desirable to transfer data between functions. For example, data on suppliers from an inventory application may be required by accounts payable. Data files which have uses outside the application program should be easily transferred.

2. **Flexibility within the program.** The program itself may offer the user options in specifying data to be retrieved, structure of data input, and reports. Review the reports and data analysis you require, and compare these with the capabilities of the program.

3. **Flexibility to change the program.** In some cases it may be necessary to modify a program in order to obtain the product you require. This may be done by you or a programmer you hire, or, more likely, it may be done by the program developer. In order for you or your programmer to change the program, you must have access to the "source code" of the program in the language in which it was written. "Object code" of the program, which has been translated to run on the computer and coannot be changed, is generally distributed. The source code of proprietary or commercial software is sometimes not provided, as the developers keep control over distribution of the program; however, you should be able to obtain source code for public domain programs, or custom software.

   Application programs may be written in any of a number of different languages, which make it more or less difficult to change them. Some are written in database management languages which makes minor modification relatively easy to do. The ease of making changes to programs written in PASCAL, Fortran, or BASIC depends on the quality of the programming and documentation.

4. **Data capacity.** A basic concern for all programs is whether the program is capable of handling the amount of data you generate or

expect to generate in the next few years. The capacity of the program may depend on the amount of memory available in the machine on which it is run.

5. **Expansibility.** Some application programs are designed to include all the functions of a particular application. Others consist of modules which only handle portions of the function. Consider the likelihood that you may wish to add other modules in the future. In order to do this, data structures have to be transferable, and mechanisms for coordinating the modules may be required.

6. **Cost.** Implementation of an application includes numerous costs which may not be included in the cost of the program itself. Setting up an application will include:

   -installation
   -training of staff
   -input of initial database
   -duplications of the function during the test period

   The cost of these activities may be included in the provider's charge, included in a contract with a consultant, or absorbed by your payroll.

7. **Support.** Application programs may be less polished and trouble-free than the much used generic programs. They are also more likely to be tailored for your particular requirements. One of the advantages of purchased application programs over public domain software, is that you should be able to expect ongoing support from the developer or supplier. Look for a warranty or test period to ensure that the program will do what it claimed to do correctly. Ensure that the provider will take responsibility for correcting problems. Consider the availability of telephone support should you have problems or questions.

8. **Documentation.** As always, good documentation is essential to the effectiveness of the program in use. This may not be a top concern of developers of application software. Check the documentation to make sure it is well organized, deals with the application in a way that is useful to the user of the program, and can be understood by someone who does not have a degree in computer science.

9. **Fit with agency procedures.** Users of the program should not have to turn their procedures inside out to adopt the application program. Data should be input in a form easily adapted from current data sources. Reports should be available in the forms needed by your agency. The vocabulary of the application and procedures performed by the program should be compatible with current procedures to be easily understood and used by agency staff.

Conclusion

Application software for transit is in a less advanced state of development than are the generic programs. Development of application software tends to lag behind the availability of hardware. When a new hardware product comes on the market, development of software for it begins. Several months or years later that software is completed and the product begins to mature. Products with general applicability and commerical potential, such as generic programs, tend to be available first, due to the highly competitive mark and close cooperation between the hardware and software developers. More esoteric (and less lucrative) programs, such as transit applications, appear later. At the present time a large number of transit application programs are being developed, but relatively few are already available.

Initial transit-specific products tended to be transferred from other industries, such as trucking, or sized-down verions of programs already available on microcomputers. However, programs designed initially for microcomputer-based transit applications are now reaching the market.

APPLICATION	WHAT TO LOOK FOR
ALL APPLICATION SOFTWARE	
	Transferability of data
	Flexibility within the program
	Flexibility to change the program: Database management language, source code
	Data capacity
	Expandibility
	Cost: installation, training, testing
	Support: Debugging, test period, telephone support
	Documentation
	Fit with agency procedures: Data input, reports
OPERATIONS	
Scheduling and runcutting	Flexibility to accommodate work rules
	Report generating capabilities
Fleet Maintenance	Data input procedures and checking
	Flexibility to generate one-time reports
PLANNING	
	Data requirements of the program
FINANCIAL FORECASTING AND ACCOUNTING	
Accounting	Ability to use Section 15 expense codes
	Flexibility to define reports required

Figure 4.1 What to Look For in Application Software: Summary

CHAPTER 5

OPERATING SYSTEMS

This chapter discusses the most basic element of system software, operating systems. The first section concerns the function of the operating system, and is followed by discussion of operating system selection. Finally, some of the more widespread operating systems are described briefly.

Function

The operating system is the foundation of all computer use. It is a program which is designed for a particular microprocessor chip and allows the user, or other programs, to control the operation of the computer hardware itself. The operating system:

1. Coordinates the various parts of the hardware system. It facilitates adding optional peripherals, such as disk drives, printers, or modems.

2. Handles input and output. Retrieval of data from disk files, saving programs and data on disks, and sending output to the printer are all tasks of the operating system.

3. Controls disk formats and space allocation.

4. Coordinates user needs for memory, processor time, and communication in multi-user systems.

Thus the operating system is a common denominator that makes it possible for a variety of programs to be run on the system without each one having to deal with the specific characteristics of the hardware being used. It has been described as analagous to a waiter, who takes and delivers orders, picks up and delivers the food, prepares the bill, receives payment, and clears the tables.

Usually, the operating system comes on a diskette which must be loaded in the machine at the time that it is turned on. The first thing that the computer does when it is turned on is to look for the operating system on the diskettes. If it finds it, large parts of the operating system are read and stored in memory, making the computer ready to run application programs. This process is called "booting." Programs which can be booted directly, without loading an operating system diskette first, have the necessary components of the operating system included on the program diskette. In addition, some computers come with part of the operating system stored permanently in the unerasable part of the

computer's memory or Read Only Memory (ROM), so it is already there when the system is turned on.

Although the operating system is working continually behind the scenes when an application program is run, the part of the operating system which the user most often contacts directly manages the storage of data and program files on diskettes or hard disks. The operating system "formats" new diskettes with its own particular organization, so that files can be saved and indexed in a systematic way. It allows the user to name files and writes the contents of a diskette on a directory so that files can be found when they are needed. It copies files from one diskette to another, or to the screen or printer.

The operating system contains the BIOS or Basic Input/Output System. The BIOS coordinates the various peripherals, such as printers, monitors, disk drives, and keyboards which are hooked up to the microcomputer. In some cases the BIOS may need to be changed by the user when the system is first set up in order to specify the characteristics of the particular equipment in use.

In addition, some operating systems include other useful functions. The UCSD p-system, for example, includes a text editor which can be used to retrieve, modify, and save files. Features which are being incorporated in new operating systems are centered around the growing feasibility of networking microcomputers. "Multi-tasking" systems enable a user to put a particular program on hold while switching to another one. "Windowing" is one way of flipping back and forth between programs. "Multi-user" systems allow users on several terminals to share computer time and storage. New developments also tend toward making operating systems easier to learn and use.

Operating systems are written to be used with, and make the most of, specific CPU microprocessor chips. The CPU is the heart of the computer itself and does the actual computing as well as coordinating the other tasks the microcomputer must do. Only four kinds of CPU microprocessor chips have been used in almost all microcomputers. The major difference between them is the size of bundles of data which they process at a time. The smallest unit of data is called a "bit," and the earliest microcomputers, using the Z-80 or CBM 6502 microprocessor, processed data 8 bits at a time. The second generation of microcomputer, including the IBM-PC and many similar machines, uses a 16 bit microprocessor, the Intel 8088. An increasing number of new microcomputers use the Zenith 68000 microprocessor and process data 32 bits at a time. The bit size of the microprocessor determines how fast the microcomputer works and the amount of memory (Random Access Memory, or RAM) which can be used.

What to Look For

In general, the choice of an operating system is one of the most fundamental in selecting a microcomputer system. It is generally desirable to pick only one, and stick with it in order to avoid confusion, and to give the most flexibility in the use of the system and compatibility between programs. For example, if you save a file of data on diskette using

operating system A, you will not be able to work on that data with any program in operating system B, because they format data differently on the diskettes.

Any application program which you may wish to buy will be available for use with one or more particular operating systems. Likewise, a limited selection of operating systems may be available for a particular computer. Sometimes one comes free with the computer, although others may be purchased. Thus, the choice of an operating system may be made implicitly if you identify particular application software which suits your needs. The application, or combination of applications, you desire may only be available on one operating system.

Three types of factors should be considered in selecting an operating system. It is important that the operating system is and will continue to be widely used and supported by software industry, as indicated by program availability and the outlook for the system. Second a number of features such as a text editor, memory, multi-user support, multi-tasking, hard disk support, and ease of use, are helpful for routine use. Finally, more advanced features, including a debugger, linker and 8087 coprocessor support may be valuable for extensive programming.

1. **Program availability.** The flexibility of the operating system depends on the number and type of programs which are written for it. More application software is usually written for operating systems which are available for a number of different microcomputers. A "house brand" operating system, written and distrbuted for only one machine may constrain you in the future to using only application programs written for that machine. This would not matter if you only make use of generic or off-the-shelf application programs available for that machine, or if you plan to use custom written applications.

2. **Outlook for the system.** The future flexibility of your system will depend largely on whether the operating system is revised and modified to incorporate new developments and ideas. The operating systems which are kept current will be adopted for new machines and selected for new software development. For small systems planning to make use of generic or commercial software this may not be a significant constraint. However in cases where the microcomputer is likely to be a first step to future automation, obsolescence could become a problem.

3. **Editor.** This function of the operating system facilitates making changes to files of text or data.

4. **Sufficient memory.** The amount of internal memory which can be used by the computer is determined by the operating system. This memory must hold the operating system itself, the application program, and part or all of the data being used. Your specific memory requirements will be determined by the application programs you plan to use. The hardware of the computer also limits the amount of memory which can be used. Because of the memory limitations on early

microcomputers, efficiency and compactness of the operating system was desirable, to maximize the space for application programs. More recently developed 16 bit computers have less memory constraint, so memory can be traded off for additional features and ease of use.

5. **Multi-user support.** If you expect your microcomputers to be connected in a network for shared use of data and equipment, the operating system you select should support this configuration. Alternatively additional system software is required.

6. **Multi-tasking.** A recent development in operating sytems is the ability for a user to switch back and forth between applications and programs. This enhancement adds to the flexibility of the microcomputer.

7. **Hard disk support.** If you plan to use a hard disk for storage of a central database or programs, make sure that the operating system you are considering will support it.

8. **Ease of use.** You are more likely to use the capabilities of the operating system if it is easy to learn. English-like commands and menus both help to make the operating system easier to learn and use.

9. **Debugger.** A debugger helps the programmer to locate errors in the program by providing a window into the memory of the computer.

10. **Linker.** A linker allows portions of a program to be written in machine language and later incorporated in the main program. Writing certain portions of the program in machine language can speed up the program.

11. **8087 coprocessor support.** The 8087 coprocessor is a chip which can be added to the computer to handle mathematical calculations. The 8087 may speed up tasks which require extensive calculations.

Major Operating Systems

There are four families of operating system commonly in use on microcomputers: CP/M, MS-DOS, the p-system and UNIX. Within each one there are numerous variations, developed for use on particular processors or microcomputers, or to allow particular configurations of hardware. Some, for example, do not support the use of hard disks.

CP/M

CP/M was the first operating system to be widely used on microcomputers. Developed by Digital Research Inc., it is available on 8 bit microcomputers using the Z80 or Intel 8080 microprocessor, such as the Osbornes, TRS80, Commodore 64 and many others. An updated version, CP/M86, is available for use on 16-bit microcomputers with the Intel 8088 and 8086 chips.

Early versions of CP/M are limiting, because they only allow the use of 64k (64,000) bytes (each byte equals 8 bits) of memory, 8k to 10k bytes of which is occupied by the operating system itself. Version 3.0, Concurrent CP/M, has overcome the memory limitation, and also allows a user to switch back and forth between different programs running simultaneously. CP/M has a Basic Input-Output System (BIOS) which may need to be tailored to the particular equipment on which it is used. CP/M does not support graphics. Another difficulty is that the diskette formats used by the different versions are not standard so that a program or data written on one machine or version cannot be read on another machine.

CP/M is in a mature state. Over the years it has been in general use it has acquired a large number of dedicated users, and a considerable body of available software. It is being updated to keep pace with technical developments, and thus remains a viable operating system.

MS-DOS

This system was developed by Microsoft for the IBM-PC, and is known as PC-DOS in that version. However, it is also used on a number of machines which use the Intel 8088 and 8086 processor. MS-DOS uses easy to remember English commands with straightforward syntax (or command format). The language is oriented toward the perspective of the users, while CP/M reflects more closely the mechanics of the machine. However, functionally the two systems are quite similar. MS-DOS does consume more memory than CP/M. The variety of disk formats in use limits the transferability of programs and data between machines using MS-DOS. Many of the advanced features of operating systems, which first were introduced in UNIX, have now been incorporated in MS-DOS. These include concurrency or multitasking, and sophisticated directories for easier organization of files on disks.

The majority of new commercial software is being made available on MS-DOS, due to the number of types of machines it runs on, the number of users of these machines, and its promising future.

The p-system

The p-system is more than an operating system, it includes aids for the programmer and programming languages. It was developed at the University of California at San Diego (UCSD) and has been in existence in various forms since 1974. It incorporates several concepts which make it particularly versatile and suitable for the program development. Because of these features, it was adopted by UMTA as a desirable system for development of transit application software. Much of the software developed so far under UMTA funding has been written in the Pascal language on the p-system. However, it has not been widely accepted commercially, and many of the popular software packages are not available on it.

The objective of the p-system is to facilitate the transfer of programs from one computer to another. In order to do this, a standard form of several programming languages, such as FORTRAN, BASIC, and Pascal, has been incorporated in the system. In order to make the p-system

available on a new machine, it is only necessary to rewrite a small portion of the operating system. This makes the entire body of p-system software available for the new product. (In practice there are other problems with transferring p-system programs. For example, different versions of the operating system are in use and disk formats are not necessarily compatible.)

Another unusual feature of the p-system is that it includes program development tools. Several programming languages may be selected. A text editor, intended to aid the programmer in writing programs is also included. This makes the system particularly attractive to programmers.

The most obvious difference between the p-system and other operating systems to the user is that it makes use of menus. For example, the main menu obtained after loading the system allows you to choose between the Editor, Filer (containing most of the usual operating system functions) Compiler, and several other functions. To the initial user this is easier, because you do not need to remember to look up so many commands. However, the complexity of the system and the way that it handles programming languages also tend to make it slower, and more cumbersome for experienced programmers to use.

UNIX

UNIX is an operating system designed by Bell labs specifically for multi-user microcomputer systems. Because of the power and speed requirements of a multi-user system, UNIX, and various versions of it, such as XENIX and VENIX, are available for the microcomputers which use 32 bit processors, such as the Motorola 68000. In addition to the basic operating system functions, it includes various functions to increase the power and versatility of the system and to aid the programmer.

At present the number of microcomputers capable of handling UNIX' memory requirements is quite small and those that exist are expensive. As a result the market for UNIX application software is limited and little commercial software has been developed. Some transit systems are using this operating system to develop multi-user microcomputer systems, and are using custom or proprietary software for a range of applications.

The benefits of networked and multi-user systems are likely to result in the growth of the multi-user market. The significant attributes of UNIX such as its programming utilities and multi-user support, are now available with recent versions of MS-DOS and Concurrent CP/M.

Conclusion

Having selected promising microcomputer applications for your agency and a general microcomputer system configuration, your choice of an operating system may be limited. However, it is worth understanding the role and characteristics of the various operating systems before proceding with one selected by default.

CHAPTER 6

PROGRAMMING LANGUAGES

This chapter will be of most value to managers interested in contracting for development of custom software, or considering writing simple application programs.

Many microcomputer users can make use of the software packages or programs available and may never need to use a "high-level" programming language. If a program is not available commercially for a particular application, it may be necessary to write a program yourself, find someone else who has written one and adapt it to your needs, or hire someone to write one. Usually a programming language is provided free with your micro which may be suitable for these tasks. The need for a language may only develop as you become familiar with your system and start to place increasingly specific demands on it. Possible applications include writing short programs to modify files of data for use by other programs, or developing custom programs. Writing an extensive application program is a major undertaking which is best left to experienced programmers.

Characteristics of Languages

There are any number of languages in use for developing computer programs. Each one has particular strengths and weaknesses which make it appropriate for particular types of programs, or appeal to different programmers.

The spectrum of languages extends from machine language (the language of the machine itself), through assembly language (in which some of the machine language is replaced by logical expressions, such as "add"), to the high level general purpose languages, such as BASIC, FORTRAN, Pascal, and COBOL. Flexible programs such as the generic programs could be considered a very sophisticated high-level language. The high level languages are more tailored to a particular task, easier to use, and create slower programs than assembly or machine languages. Programming in machine or assembly language is best left to specialists.

There are numerous variations, or dialects, to each of the main languages. These minor differences in syntax reduce the transferability of a program from a system with one dialect of the language to another. Some languages have a designated or de facto standard, which increases the likelihood of transferability.

Compiled/Interpreted

All programs written in languages other then machine language must be translated into machine language to run. This can be done by using

either a compiler or an interpreter. An interpreter automatically translates the program command by command as it runs, without the user being aware of the process. This slows down the program, since commands which are repeated must be interpreted each time. Alternatively, programs may be translated once into machine language by a compiler when they are completed. The high level language "source code", the set of program instructions as written, becomes executable "object code." This compiling process reduces the user's flexibility, because it adds another step to the writing of what might be a very simple program. In addition, object code cannot be changed or adapted. Any changes must be made to the source code and re-compiled. However, compiled programs run much more quickly, and are less likely to be changed by future users. In general, compiled languages are suitable for development of complex application programs, and major programming tasks, because of their speed. Interpreted languages are more convenient for day-to-day minor programming tasks. When purchasing a language, you will sometimes have a choice between compiled and interpreted versions or dialects. Some languages are available in only one or the other form.

Purchased off-the-shelf programs may be written in a high level language, such as FORTRAN or Pascal. In the compiled form which you purchase you may never be aware of this, but you cannot modify the object code. Some software distributers provide purchasers with the source code in the high level programming language. This allows users to modify the program to fit their requirements.

Some purchased compiled programs do not contain all the elements of the language needed for the program to run. In this case, if you do not plan to use the language for programming, you may be able to buy a "run-time" version of the language. The "run-time" packages are less expensive than the whole language package, and allow you to run programs previously compiled from the language; they do not enable you to write, modify, or compile programs.

Structured/Unstructured

A major difference between programming languages is whether they are structured or not. Structured languages include various built-in mechanisms for organization, so that statements within any portion of the program will be followed in order. This makes the program easier for someone else to adapt, and the logic of the program easier for the programmer to keep track of. This can become important when the program being written is long and/or complex, will be made available to other agencies and adapted to their needs, or when the program may be used in future by others who might need to adapt it. On the other hand it does require more forethought to structure a problem to conform to these patterns. An unstructured language uses statements like "GO TO" to move the action to different portions of the program as required.

Microcomputer Languages

The dominant languages for programming in the transit industry at this time are BASIC and Pascal, although numerous other languages are available.

BASIC

BASIC is a fairly new language which was developed for microcomputers. The de facto standard was developed by Microsoft Corporation and is known as Microsoft Basic. BASIC is an easy-to-use unstructured language. Because of this, and because it comes free with many machines, it is very commonly used for the day-to-day programming tasks. Most BASICs are interpreted. Recent versions are tending to be more structured and compiled, making them appropriate for more extensive programming.

Pascal

Pascal is a fairly new, very structured language suitable for serious programming on microcomputers. Much of the UMTA sponsored transit application software has been developed in Pascal. It was conceived as a teaching language but has become particularly popular among professional programmers because of its organization. The de facto standard is the UCSD Pascal, a compiled version.

FORTRAN

FORTRAN is one of the most popular languages on larger computers. However, little microcomputer software has been developed in FORTRAN. It is effective for mathematical applications and number-crunching, but less suitable for text-processing and handling large files. It is usually compiled, and is fairly unstructured.

COBOL

This language has been widely adopted on large computers for commercial applications but is little used on microcomputers. Its greatest strength is in handling large files of data, and it handles input and output operations quickly, but is less effective for numerical calculations. It is an unstructured language and results in long, wordy programs. It is compiled, and requires large amounts of memory, which makes it less suitable for small microcomputers.

Other Languages

Modula-2 is a new successor to Pascal, and is also compiled under the UCSD p-system. It eliminates many of the shortcomings of Pascal, and is more flexible and consistent than Pascal. It is only available for 16-bit microcomputers and is not widely used at this time.

C is a structured language which promises to be widely used in the future because of its association with the multi-user operating system, UNIX. It is transportable between machines running UNIX.

Forth and LISP are other less widely used languages of interest to computer scientists and programmers.

Training

In order to write programs for any purpose it is necessary to have some exposure to the general concepts of programming. The documentation provided with the programming languages is not intended to provide this.

Courses in programming are available in most communities in community colleges or extension programs. These will introduce the concepts common to all programming, such as use of variables, program logic, and structure. Select a course on the language you expect to be using, even if it is on a different type of computer. The detailed use of individual commands may be different, however the general principals will be the same, even on different machines. The documentation for your own version of the language will provide convenient reference material on the commands.

Conclusion

The choice of a programming language depends on what it will be used for. It is quite possible to use a microcomputer for many useful jobs and never use a programming language. Many minor day-to-day tasks can be accomplished using the language which came with your computer, probably BASIC. Development of extensive programs probably should be done by an experienced programmer using a more structured, compiled language such as FORTRAN, or Pascal.

CHAPTER 7

UTILITIES

Utilities are programs that perform frequently required tasks which enhance the use of generic or application programs. Many of the functions they perform are like more powerful versions of operating system functions, which may make your system more convenient and flexible to use. Other utilities assist program developers by helping to generate, manage, and revise long programs. Utilities may also help you to expand your use of the peripherals (printer, monitor, and disk drives) hooked up to your system, by gaining more control over them and increasing your range of commands.

Several of the more usual and useful types of utilities are described below:

-spoolers
-RAM Disk
-communications
-networking
-screen formatters

Utilities are generally not very glamorous programs, and tend to be written by programmers for experienced computer users. While they will do the job, they are not necessarily user-friendly. They also are unlikely to get much publicity; you may have to go looking for the program to do your job. Most utilities cost less than $100.

Utilities will be most useful for microcomputer users who have become comfortable with the use of generic or application programs on their machines and wish to enhance its convenience and capacity. In some situations utilities will be required by the hardware selected for the system.

Spoolers

Spoolers are programs which allocate a certain amount of the microcomputer's memory as temporary storage for information being sent to the printer. Since the computer can send information to the printer much faster than the printer can print it, the computer must wait for the printer to keep up. Thus, using the printer may tie up the microcomputer for long periods of time. The spooler allows material being printed to be rapidly moved into a block of the computer's random access memory (RAM), from which the printer can retrieve it as required, while the microcomputer is used for other tasks. (Random access memory is the computers internal working memory.)

Spoolers can be obtained which allocate different amounts of memory for this purpose. The amount of memory allocated can be selected by the user and will depend on the total amount of memory available in the particular microcomputer system, and the memory requirements of the programs being used.

Spoolers are often provided free with expansion boards which hold additional memory for the microcomputer. Alternatively they may be available through a users group, or at fairly low cost from a software distributer. If your computer does not have sufficient memory to allocate some to a spooler, a separate piece of hardware called a buffer can be purchased to provide the temporary memory outside the computer.

RAM Disk

A utility program can be used to allocate some of your internal random access memory (RAM) to a RAM Disk. Random access memory is the computer's internal working memory which is erased when the computer is turned off. If you have more RAM than you need to run your application program, the extra capacity can be designated as a RAM Disk. The RAM Disk is given a letter name, like the floppy disk drives, and can then be used to store files in exactly the same way as external disks. This is particularly valuable when you are reading from and writing to disks extensively, because it is much faster to read or write from RAM than it is from floppy or hard disks. However, when the computer is turned off the RAM Disk will be erased and disappear. The disk's contents must be copied to a hard or floppy disk before turning off the computer in order to be saved.

RAM Disk programs are often provided free with memory expansion boards.

Communications

Communications programs are required if the microcomputer is to be used to transfer data or information by telephone. Communications gives the computer user the capability to communicate with other computer users, to make use of bulletin board services and information services, and to upload data and programs to other computers and download them from other computers. At the present time the most useful application of this capability in the transit industry occurs in agencies with maintenance or other facilities at scattered locations. Data, memos, or messages can be transferred between the various facilities by telephone.

The communication program performs many functions including setting communications parameters so that communication between the computers is coordinated and uses the same protocol, enabling data coming in the communcations port to be stored either on a disk or in memory, checking data coming in for errors, giving instructions to the modem about dialing the other computer, and giving the user access to data made available on the other computer.

The amount of involvement of agency staff in communications can vary. In the most basic situation the computers are both ends of the communication must be hooked up manually by agency staff. At the other extreme computers may be programmed to call each other up and exchange certain data with no staff involvement. For convenience it may be desirable to have a central computer automatically accessible to communication from a remote terminal, such as a distant maintenance facility. This requires leaving the computer on and hooked up to a modem, opening the possibility of access to the data by unauthorized users. For this reason security mechanisms should be provided for communications, either in the form of a passwork or by having the central computer return the call of a remote user requiring access.

Networking

When microcomputers are hooked up to each other, or to a common peripheral, such as a hard disk, a program is required to coordinate the various communications between the elements of the system. Functions of this program include responding to commands sent by the computer, sorting out and coordinating commands coming from several users, and coordinating the computer with the peripheral. This program may be provided in several ways. It may be permanently included in the hardware of the equipment or it may be software run on a microcomputer which is performing the coordinating function. Software may be provided with the hardware, or it may be purchased separately.

Screen Formatting

This utility is used to develop screens which appear on the monitor for inputting data to other programs. "Screens" are used in many application programs to simplify communications between the user, who may not be an experienced computer user, and the computer. The screen appears on the computer's monitor and helps to guide the user in providing the correct response to the program. The screen can be formatted to look like a paper form from which the user is inputting data. Comments may be added on acceptable values or data input procedures. The screen can be structured as a menu with a range of acceptable choices. Screens are a key element in making an application program "user-friendly."

Screen formatters are utility programs which are used by the programmer to generate the specific screens required by the program accurately, easily, and quickly. Some file or database management programs incorporate a screen formatter so that the user can define suitable data input formats.

Other Functions

Numerous utilities are available to perform other housekeeping functions for the system. These allow you to:

1. Read from and write to disk drives in a range of formats.

2. **Manage files** on a disk by sorting them, compressing them, selecting them for erasing, assigning numbers for easier reference, or even recovering files damaged or erased by mistake.

3. **Create and use menus** of operating system commands for easier use of the operating system.

4. Provide various forms of **security** for programs and files.

5. **Keep track of program structure and variables** used when programming.

6. **Increase graphics or formatting** capabilities on your printer.

Conclusion

Utilities, while rarely necessary, can greatly enhance microcomputer user. As users become increasingly familiar and comfortable with the microcomputer they will appreciate the control and flexibility which utilities can offer.

CHAPTER 8

ISSUES IN MICROCOMPUTER IMPLEMENTATION

The process of implementing the microcomputer system within the operating organization is as challenging as the task of selecting and acquiring the components of the system. The many complications of organizational structure, personalities, and logistics make this an ongoing effort. The staff time consumed by training, start-up and disruption may be as costly as the purchase of equipment and software.

Major issues which must be considered in system implementation include:

-staff support
-training
-security
-implementation process
-operating procedures

Staff Support

A key to implementing a successful system is obtaining the support of the staff who will be actually using the computer. This may be a time consuming effort, as it requires an iterative process of increasing exposure to and understanding of the computer's capabilitites while maintaining staff involvement in the application of the computer to their particular responsibilities. In many cases the computer may actually sell itself, if given the opportunity; however it is often necessary to overcome suspicion of the machines and of the project. In general, the earlier future users become involved in discussion of the system, the stronger support is likely to be generated.

Staff may respond to the introduction of microcomputers in one of several ways. Some personnel may find computers threatening or intimidating and avoid confronting the idea for as long as possible. Technically oriented individuals may be obsessed by it and want to apply it to both appropriate and inappropriate tasks. A microcomputer may also be seen as a status symbol by managers who may have few actual applications for the technology. Staff participation in a systematic needs assessment process will help to moderate these extreme approaches.

Training

A major element of early staff involvement is training. General courses on the use of microcomputers are available in most communities through technical colleges, adult education programs, or computer retail outlets. More intensive courses on the applications of microcomputers in transit are offered at several sites around the country. In general,

the generic packages, such as spreadsheets or word processors, are best learned first. They are easy to learn, help the user to rapidly overcome any fear of the machine, and have a number of immediate uses, which may strengthen the user's interest in the machine. Courses on programming microcomputers in a language such as BASIC are more valuable at a later stage, when a need for in-house programming has been identified.

Once the machine is in use in the agency, a great deal of learning may take place on the job, as users share experiences and come across particular problems to resolve. This process may be facilitated by staff participation in a users' group, either in-house, or in the community. However, the pressures of completing the tasks which must be done may constrain staff from acquiring knowledge required to make full use of the capacities of the microcomputer. For this reason, a designated class or training program may provide a very valuable forum for increasing the user's ability to benefit from the computer.

Implementation Process

The process by which the computer is implemented may contribute greatly to the ease with which it is incorporated in the agency. While this will inevitably require a certain amount of procedural change, the trauma of the process can be reduced by a careful implementation strategy.

In planning the implementation process, the following issues should be considered:

-coordination
-staging of implementation
-order of implementation
-duplication during testing period

Coordination

The development and implementation of the system should be coordinated by one person. This person should be able to resolve pressures which may result from various staff ideas of what they wish to have done. The coordination of applications in an integrated system will also have to be overseen by this one person. The person responsible for this must have time to dedicate to development and implementation of the system.

Staging of Implementation

In general, implementation of several applications should proceed incrementally. By implementing applications one at a time, the problems which will undoubtedly occur can be spread over an extended time, rather than appearing all at once. As early applications take hold, confidence in the benefits of the system will increase.

Order of Implementation

Early applications should be less crucial ones, with visible benefits. An early implementation problem should not have disastrous consequences, but the benefits of implementation should contribute to morale. The implementation period will involve considerable learning for all involved. It is better that the inevitable problems with early applications take place with an application in planning or inventory, than, for example with an application in payroll. Likewise an early success with a visible and beneficial application such as inventory will add momentum and support to the system.

Duplication During Test Period

Critical applications, particularly in audited areas, should be duplicated manually during the first 3 to 6 months of implementation in order to identify any bugs and inconsistencies, and to protect against possible failures to perform. This period will require extra effort, due to the duplication of tasks.

Operating Procedures

Once the system is installed, it will not remain stagnant. Continual change in the organization, the technology, and expectations of the system will result in ongoing change. Furthermore, in order to retain the system's usefulness, routine maintenance procedures must be considered. Monitoring operating procedures should be the responsibility of one staff person. Provision for backup support should be made for times when the responsible person is ill or on vacation.

Backup

Data stored on hard disk or diskettes should be copied frequently to reduce problems caused by possible damage to disk storage. The frequency with which copying is required depends on the frequency with which changes are made to the data, the cost of reproducing the data from the latest backup should damage occur, and the cost of time involved in making the backup. Backup copies of crucial data should be stored in a safe, fireproof location away from the computer and active data storage location. Provision for backing up hard disk storage should be included in selecting a hard disk.

Database Coordination

In any system where data is being shared by several users, the structure of the data base may need to be designed to accommodate the needs of the various users in the agency.

When one user in the agency identifies a new data requirement to be included in the database, it should be compared to data being maintained by other users to minimize duplication and maximize its usefulness in the database. For example, data on ridership generated by the operations department from fare revenue may not need to be maintained in a separate file for planning purposes.

Maintenance

As the system becomes more firmly entrenched in the operations of the agency, a failure of any component will have more serious consequences. It is necessary to ensure that, should a breakdown occur, the consequences for smooth continuing operations will be minimized. Maintenance contracts for equipment should be obtained as required. Backup equipment should be located to be used as temporary replacements for failed components.

Security

Related to the issue of database coordination is that of security. Security is required to avoid access to confidential and sensitive information by unauthorized users and to prevent unauthorized changes to data. Reasons for controlling access include privacy issues and financial security considerations, such as preventing unauthorized changes to payroll, inventories or pass revenue data.

Three different levels of security can be provided to each user for various data structures. A user may be provided with **write access** to data he or she may need to both read and change. **Read access** is available for users who require data which is on file but do not need to alter it. Finally **no access** may be available to sensitive information except to authorized users.

Each user should have access to the minimum amount of data which allows them to do their job effectively. In general, write access to relevant data items is provided to those clerical and support staff whose reponsibility is the maintenance and updating of data. Top management requires read access to relevant data, but should not have write access; management should be able to review data, but changes should be made by support staff. The manager responsible for maintenance of the computer system should have access to all but the most sensitive information.

Access to data may be controlled in one of several ways. Physical access to machines and/or diskettes may be controlled in some circumstances by locks and keys. In more complex systems, password systems may be used to provide access to each employee as required. Some database managers incorporate password security measures which control access to date files or, in some cases, to specific fields of data within the files. Separate utility programs are also available allowing security assignment by password. In some cases, access to data may be allowed for limited time periods, as required. Whether physical security, keys, or passwords are used procedures should be established to maintain the integrity of the system. The likelihood of passwords or keys being left in obvious places for unauthorized users to find should be minimized.

User Support

The benefits of the system can be increased by active involvement of staff who use the system. An in-house users group, meeting regularly

over a brown-bag lunch can provide a forum for exchange of ideas and discoveries, and discussion of problems. It may also be desirable to maintain subscriptions to selected relevant periodicals for the use of in-house microcomputer users. Staff participation in outside training and user groups can also be encouraged.

In many agencies some individual employee becomes particularly interested in the use of the microcomputer and makes the effort to familiarize him or herself with it beyond the immediate needs. This should be encouraged because that person becomes an informal resource to other users, and reassures them that support is available should they need it. The result is an atmosphere of active exploration of the microcomputer's potential, involving a large portion of the agency's staff.

Conclusion

The success with which microcomputers are introduced to an agency depends very much on the strategy adopted for implementation. A positive approach to the technology by individuals using it is required in order to generate beneficial applications. Training, staff involvement throughout the process, and ongoing support contribute to the effectiveness of staff use of the technology.

Microcomputers challenge the organization as a whole, which must adapt to accommodate their capabilities. Because of the information made available by the computer and sharing of the equipment by various staff members, coordination and control of the microcomputer are required. Implementation must be coordinated and operating procedures must be established. In multi-user or hard disk systems formal security procedures may be necessary.

Like any tool or asset, microcomputers will not create benefits by themselves. Their value to the organization depends on how they are managed, the means by which they are introduced in the agency, establishment of procedures to support their ongoing use, and creative response to their potential contribution to a variety of applications in the agency.

PART II

APPLICATIONS OF GENERIC SOFTWARE FOR TRANSIT

CHAPTER 9

INTRODUCTION TO PART II

At the present time, applications of the generic programs dominate the use of microcomputers in transit. Numerous agencies have identified specific applications of spreadsheets or database managers which are of value in their particular agency. Part II documents a sample of the applications which are in use in the industry.

The characteristics of generic programs make them particularly suitable for the transfer of applications between agencies. The functions performed by the various products of each type, such as the different commercial spreadsheets, are quite similar. The actual process of setting up the application on the microcomputer is quick and easy. The flexibility of the programs allows modifications to be made to a basic concept in tailoring it to the circumstances of each agency.

Development of Generic Applications

Development and use of applications of generic programs involves five steps:

1. **Identifying** potential applications.
2. **Structuring** the application.
3. **Generating** input data.
4. **Setting up** the application.
5. **Using and maintaining** the application.

Identification of the application involves making the link between the mechanics of a manual function and the capabilities of the generic program. Someone must have a good understanding of the task being done, and the use of the program in order to make this connection. In some cases it also involves seeing beyond the way a task is currently done, and identifying other techniques of analysis which would be valuable.

Developing the structure of the application on the spreadsheet or database manager requires working out the details of fit between the application and the program. The layout of the spreadsheet and formulas used, or the data fields in a database manager, must be specified. This step is time consuming and requires a good understanding of the function being automated as it is performed in the agency.

Some applications will require generation of background data. Applications which were previously performed manually will be complete with the necessary data. New applications may require development of new data. For example, a cost allocation application will require development of unit costs by hour or revenue-mile. A procedure to generate ridership by fare type from route-level revenue data requires accurate fare classification counts by route. In some cases, development of background data may be more onerous than development of the application strategy.

Setting up the application on the microcomputer is fairly straightforward once steps 2 and 3 have been accomplished. None of the applications documented in the following chapters required more than 1 and 1/2 hours to set up.

Use and maintenance of the application depends on the specific function being performed. Some spreadsheet applications are one-time problems, used to support a particular decision and then filed. Other applications require ongoing maintenance: entering current data, reviewing background data and assumptions, filing obsolete data. These activities would also be required by an ongoing manual procedure.

The first three steps of the development procedure create the greatest obstacle to more widespread use of generic programs for a range of applications. Many transit professionals do not have the familiarity with the generic programs to recognize potential applications. If they do, they may not have the time to work out the details of the application and obtain the additional data required.

Use of Documented Examples

The application examples in the following chapters are documented for the purpose of facilitating the identification and structuring of generic program applications. These examples have been identified and implemented as worthwhile applications in transit operations. In addition, they provide prototype methods of structuring the application, which worked in the developing agency. Users may also find in the examples helpful techniques that may be applied to other applications.

These applications are not intended to be adopted in their present form by other agencies. Modifications to the methods incorporated in the applications (cost allocation methods or response to fare increases for example), the structure of the application (specific data maintained, performance measures calculated, or market segments used), and the background data (cost measures or ridership data) will be required. It is hoped that they will provide a starting point for implementation of similar applications and may be a stimulus for new ideas.

The documentation entitled Application, Use, Assumptions and Variations indicates what the application does. The notes in the documentation are more detailed and will be most useful to beginning users when used at the computer in setting up an application similar to the example. It is assumed that a person who plans to implement or modify

these applications has a basic familiarity with the program being used. This level of understanding of the generic program can usually be obtained in several days use of the program.

List of Applications

Spreadsheets

General Applications

- Time Trend Analysis
- Multiple Regression
- Preparation of Operating Documents

Budgeting

- Wage and Fuel Budget
- Operating Budget
- Budget Comparison
- 10-Year Operating Budget
- 10-Year Capital Budget
- Cash Flow Projection
- Cash Flow Manager

Financial Analysis

- Fare Structure Analysis
- Cost Tracking and Forecasting

Service Monitoring

- Monthly Route Summary
- Monthly Reporting System with Macros
- Service Variance Tracking
- Ride Check Analysis and Summary

Service and Operations Planning

- Route Evaluation
- Schedule Builder A
- Schedule Builder B
- Run Summary

Database Managers

- Customer Service Records
- Client Records
- Parts Inventory

CHAPTER 10

SPREADSHEET APPLICATIONS

Spreadsheets are the most widespread use of microcomputers in the transit industry at this time. They offer two great benefits:

1. **Structured relationships.** Interaction between variables, such as between service levels and costs, can be structured so that a range of assumptions and scenarios can be tested. This provides a powerful tool to the manager in understanding the possible outcomes of a range or alternatives being considered.

2. Visual presentation. Confusing techniques, such as cost allocation methods or elasticity effects of fare changes on ridership, can be presented in a highly visual, easily understood, form. By communicating these techniques in this way, they may become more useful to transit managers.

The applications which follow are examples of spreadsheets which are in use by transit agencies. They have been modified in some cases to make them more generally applicable. In other cases, elements of two examples of the same application have been combined.

These applications provide a starting point for developing a tailored application for the particular requirements of each agency. Although the specifics of route and fare structure, budget format, etc. will vary between agencies; however, the principles of the examples remain common.

In many cases the most time consuming part of these applications is assembling the background data and assumptions required. The spreadsheets are vulnerable, as is any method, to "GIGO"--garbage in, garbage out. Results are only as good as the data which is used; however, often their appearance of computer output adds to their credibility. Spreadsheets, by organizing the problem and handling the mechanics of computation, will allow the user to focus on the data and the method of solution and thus to obtain useful results.

Documentation

1. Notes are given to clarify the contents of key cells, either working across or down the spreadsheet. For examples in which all of the cells of a column contain similar information, the notes will describe cells in the columns from left to right.

2. Cell identification is in the format column, row. For example, C6 refers to the cell in column C, row 6.

3. Formulas are given only for a representative cell in a column or row of similar cells. Generally the formulas can be entered in the cell indicated, and then copied or replicated down the column or across the row.

3. Data inputs are one of three types: "Data" is direct statistical background information. "Assumptions" are data requiring the use of judgement, such as forecasts. "Input Data" is current data being processed by the template.

4. Totals are noted only when they are not simply the sum of the row or column.

5. Underlined cell names in formulas are absolute, and should not change when the formula is copied to the other cells in the row or column.

6. Functions may vary between spreadsheet packages. Those used in these examples include:

   Sum: the sum of a portion of a row or column

   Avg: the average of a portion of a row or column

   Max: the maximum value in a portion of a row or column.

   Int: the integer portion of a real, decimal number.

   If: a conditional function giving different values depending on whether the condition is true or false.

   Lookup: looks up a specified cell value in a table, which is part of the spreadsheet, and gives the corresponding value from the table.

   +: addition.

   -: subtraction.

   *: multiplication.

   /: division.

   : exponentiation (x2) is x squared

DOCUMENTATION: TIME TREND ANALYSIS

Application

This template can be used to summarize time trend data of any sort.

Use

Data for a continuous series of time periods (years, months, etc.) is input. The template calculates the percentage change from year to year, and provides a source of data for graphing time trends.

Notes

B6: Data. Operating revenue data for the first year of the series.

C7: (B7-B6)/B6 Set format to percent or multiply by 100.

D6: Data. Operating expenses for the first year of the series.

E7: (D7-D6)/D6 Set format to percent or multiply by 100.

F6: (B6/D6)

Variations

A similar analysis could be undertaken for any time series data by replacing operating revenue and expenses by the desired variable. The actual difference between time periods could be calculated as well as the percent change.

	A	B	C	D	E	F	G	H	I	J
1					OPERATING STATISTIC TRENDS					
3	YEAR	OPERATING REVENUE	PERCENT CHANGE	OPERATING EXPENSES	PERCENT CHANGE	RECOVERY RATIO	REVENUE PASSENGERS	PERCENT CHANGE	REVENUE MILES	PERCENT CHANGE
5	1975	874196		1246067		0.70	1895737		1275177	
7	1976	879255	0.58%	1327174	6.51%	0.66	1957687	3.27%	1515295	18.83%
	1977	858592	-2.35%	1337534	0.78%	0.64	1954096	-0.18%	1558367	2.84%
9	1978	807482	-5.95%	1538643	15.04%	0.52	2013199	3.02%	1607354	3.14%
	1979	825743	2.26%	1811396	17.73%	0.46	2342111	16.34%	1784255	11.01%
11	1980	816433	-1.13%	2086660	15.20%	0.39	2511443	7.23%	2010371	12.67%
	1981	837092	2.53%	2462243	18.00%	0.34	2679497	6.69%	2062584	2.60%
13	1982	891013	6.44%	2880963	17.01%	0.31	2828021	5.54%	2096268	1.63%
	1983	958147	7.53%	3168547	9.98%	0.30	3032038	7.21%	2117642	1.02%
15	1984	1019584	6.41%	3728588	17.68%	0.27	3310829	9.19%	2330709	10.06%

Figure 10.1 Time Trend Analysis

DOCUMENTATION: MULTIPLE REGRESSION

Application

This spreadsheet is used to estimate a linear equation showing the relationship between a dependent variable (pass sales) and two independent variables (x (year) and z (unemployement rate)). The equation is in the form Y = A + B * X +C * Z. Some spreadsheets and planning software include more flexible regression functions.

Data on X, Y, Z is input for each of the sample points. The template calculates the values of A, B and C, an ANOVA table, the f statistic and r^2.

Notes

B8: Data. First value of dependent variable Y.

B19: Avg (B7... B13)

C8: Data. First value of independent variable X.

C19: Avg (C7...C13)

C24: (G15)

C25: (H15)

C27: (G15)

C28: (C25*(E24/E25))

C30: (C24-C28)

D8: Data. First value of dependent variable Z.

MULTIPLE REGRESSION OF Y ON X AND Z (LEAST SQUARES ESTIMATES)

DATA POINT	PASS SALE (Y)	YEAR (X)	UNEMP RTE (Z)	Xv=X-Xm	Zv=Z-Zm	Y*Xv	Y*Zv	X*X	Z*Z	X*Z	Yr	(Yr-Ym)* (Yr-Ym)	(Y-Ym)* (Y-Ym)
1	18400	1	7.2	-3	-1.42857	-55200	-26285.7	9	2.040816	4.285714	19848.49	18687748	33309387
2	23200	2	7.3	-2	-1.32857	-46400	-30822.8	4	1.765102	2.657142	21415.28	7596300.	943673.4
3	22700	3	10.1	-1	1.471428	-22700	33401.42	1	2.165102	-1.47142	22079.07	4377957.	2165102.
4	23400	4	9.5	0	0.871428	0	20391.42	0	0.759387	0	23879.98	84942.18	595102.0
5	25200	5	8.9	1	0.271428	25200	6840	1	0.073673	0.271428	25680.88	2278469.	1057959.
6	27000	6	8.8	2	0.171428	54000	4628.571	4	0.029387	0.342857	27314.57	9879354.	8000816.
7	29300	7	8.6	3	-0.02857	87900	-837.142	9	0.000816	-0.08571	28981.70	23138725	26302244
TOTAL	169200	28	60.4	0	3.6E-15	42800	7315.714	28	6.834285	6	169200	66043498	72374285

MEANS Ym = 24171.42, Xm = 4, Zm = 8.628571

FINAL EQUATION Y= 20656.28 + 1600.239 X + -334.449 Z

coefficient of determination = 0.912527 (R-squared)

sample correlation coefficient = 0.955262 (R)

EQUATIONS

42800 = 28 b+ 6 c

7315.714 = 6 b+ 6.834285 c

c= -334.449

b= 1600.239

a= 20656.28

SOLUTION

42800 = 28 b+ 6 c

34140 = 28 b+ 31.89333 c

8660 = 0 b+ -25.8933 c

ANOVA TABLE

SOURCE	SS	D.F.	MEAN SQUARE	
REGR	66043498	2	33021749	F= 36.51240
ERROR	6330786.	7	904398.1	
TOTAL	72374285			

Figure 10.2 Multiple Regression

D19: Avg (D7...D13)

D35: (M15)

D36: (N15-M15)

D38: (N15)

E7: (C7-C19)

E24: (I15)

E25: (K15)

E27: (I15)

E28: (E25*(E24/E25))

E30: (E24-E28)

E35: 2 degrees of freedom

E36: (A13)

F7: (D7-D19)

F15: Sum (F7...F13)

F35: (D35/E35)

F36: (D36/E36)

G7: (B7*E7)

G24: (K15)

G25: (J15)

G27: (K15)

G28: (G25*E24/E25)

G30: (G24-G28)

H7: (B7*F7)

G7: (B7*E7)

G24: (K15)

G25: (J15)

G27: (K15)

G28: (G25*E24/E25)

G30: (G24-G28)

H7: (B7*F7)

I7: (E7**2)

I18: (J27)

I35: (F35/F36)

J7: (F7**2)

J25: (C30/G30)

J26: (C24-(J25*G24))/E24

J27: (B19+(J26*C19*(-1))+(J25*D19*(-1)))

K7: (E7*F7)

K18: (J26)

L7: (J27+(J26*C7)+(J25*D7))

L15: Sum (L7...L13)

L20: (M15/N15)

L21: Sqrt (L20)

M7: (B19-L7)**2

M18: (J25)

N7: (B19-B7)**2

DOCUMENTATION: PREPARATION OF OPERATING DOCUMENTS

Application

Spreadsheets can be used for preparing and updating operating documents which are in tabular form.

Use

The format of the operating document is set on the spreadsheet, along with all material which does not change regularly. This template is saved as a master. It can then be retrieved and filled in with the relevant information for each bid or scheduling period.

Notes

The accompanying examples show the type of documents which can be prepared and maintained on spreadsheets.

DISPATCHERS END TIME REPORT

WEEKDAY, AM PULL-IN, 700-1230AM

ROUTE 1						ROUTE 2					
FOREST			DOWNTOWN			PARK			DOWNTOWN		
TRAIN	TIME	VAR.	TRAIN	TIME	VAR.	TRAIN	TIME	VAR.	TRAIN	TIME	VAR.
37	701		41	701		4	706		13	700	
45	715		42	715		28	713		21	715	
36	720		47	728		29	726		26	728	
49	730		50	758		13	756		4	758	
56	745		49	828		26	826		29	828	
41	800		41	858		4	856		13	858	
47	830		47	928		29	926		26	928	
50	900		50	958		26	956		29	1028	
49	930		49	1028		29	1026		26	1128	
41	1000		41	1058		26	1056		29	1228	
47	1030		47	1128							
50	1100		50	1158							
49	1130		49	1228							
41	1200										
47	1230										

ETC...

A.M. TRIPPERS
EFFECTIVE: JANUARY 23, 1984

TRIPPER	TRAIN	PULL OUT	PULL IN
787 PARK	3	6:00	7:45
789 PARK	9	6:05	7:50
386 SPR.CRK.	8	6:09	7:51
788 PARK	4	6:10	7:55
54 LAKE	11	6:12	7:53

ETC....

Figure 10.3 Operating Documents

DOCUMENTATION: WAGE AND FUEL BUDGET

Application

This spreadsheet can be used to estimate the operator wage fuel components of an annual budget. It can also be used with qualifications to estimate the impact of changes in the amount of service offered.

Use

Data on the number of days of each type of service per month, the amount of service per each type of day, and labor and fuel unit cost are input. The template caluculates the amount of service per month, and associated labor and fuel costs.

Assumptions

The template uses system average data for straight and overtime pay hours per service hour in all wage calculations. These average statistics may not apply for small or non-uniform changes in service provided. It is assumed that the service structure for the year being budgeted remains similar to that under which these operating statistics were developed.

Notes

B6: Data. Number of days of weekday school service offered in January.

B24: Data. Hours of service provided on school weekdays.

B25: Data. Miles of service provided on school weekdays.

C6: Data. Number of days of weekday no school service offered in January.

F6: (B6*B24)+(C6*C24)+(D6*D24)+(E6*E24)

F25: Data. Fleet average fuel mileage, miles per gallon.

G6: Data. Straight pay hours/bus hour.

BUDGET CALCULATOR

Month	Weekdays School	Weekdays No sch.	Sats.	Suns.	Bus Hrs.	St. Hrs/ Bus Hr.	Ot. Hrs/ Bus Hr.	St. Time Hours	Overtime Hours	Straight Rate	Overtime Premium	Overtime Rate	Straight Wages	Overtime Wages	Total Wages
January	21	0	5	5	9637	1.02	0.12	9830	1156	$9.10	1.50	$13.65	89451	15785	105236
February	20	0	4	4	8980	1.02	0.12	9160	1078	$9.10	1.50	$13.65	83352	14709	98062
March	23	0	4	4	10171	1.02	0.12	10374	1221	$9.10	1.50	$13.65	94407	16660	111067
April	21	0	5	4	9592	1.02	0.12	9784	1151	$9.10	1.50	$13.65	89033	15712	104745
May	21	0	4	6	9467	1.02	0.12	9656	1136	$9.10	1.50	$13.65	87873	15507	103380
June	18	4	4	4	9454	1.02	0.12	9643	1134	$9.10	1.50	$13.65	87752	15486	103238
July	0	20	5	6	7685	1.02	0.12	7839	922	$9.50	1.50	$14.25	74468	13141	87609
August	0	23	4	4	8331	1.02	0.12	8498	1000	$9.50	1.50	$14.25	80727	14246	94973
September	20	1	4	5	9342	1.02	0.12	9529	1121	$9.50	1.50	$14.25	90524	15975	106499
October	21	0	5	5	9637	1.02	0.12	9830	1156	$9.50	1.50	$14.25	93383	16479	109862
November	21	0	4	5	9422	1.02	0.12	9610	1131	$9.50	1.50	$14.25	91299	16112	107411
December	21	0	5	5	9637	1.02	0.12	9830	1156	$9.50	1.50	$14.25	93383	16479	109862
Total	207	48	53	57	111355			113582	13363				1055651	186291	1241943

Scheduled					
Hours	397	317	215	45	MPG
Miles	4590	3382	2501	576	4.2

COST SUMMARY

Miles	Gallons Fuel	Fuel Price	Fuel Cost
111775	26613	$1.10	29274
104108	24788	$1.10	27266
117878	28066	$1.10	30873
111199	26476	$1.10	29124
109850	26155	$1.10	28770
108456	25823	$1.10	28405
83601	19905	$1.10	21896
90094	21451	$1.10	23596
108066	25730	$1.10	28303
111775	26613	$1.10	29274
109274	26018	$1.10	28619
111775	26613	$1.10	29274
1277851	304250		334675

Month	Driver Wages	Fuel Cost
January	105236	29274
February	98062	27266
March	111067	30873
April	104745	29124
May	103380	28770
June	103238	28405
July	87609	21896
August	94973	23596
September	106499	28303
October	109862	29274
November	107411	28619
December	109862	29274
Total	1241943	334675

Figure 10.4 Wage and Fuel Budget

H6: Data. Overtime pay hours/bus hour.

I6: (F6*G6)

J6: (F6*H6)

K6: Data. Effective or average straight wage rate.

L6: Data. Overtime premium. 1.5 represents time and a half.

M6: (K6*L6)

N6: (I6*K6)

O6: (J6*M6)

P6: (N6+O6)

Q6: (F6*11.6) Average operating speed of 11.6 miles per hour used in example.

R6: (Q6/F25)

S6: Data. Projected price of fuel for January.

T6: (R6*S6)

The last three columns are a summary of data in the table for presentation or reference. W6 is P6. X6 is T6.

Variations

A variety of different assumptions can be incorporated in this template. Wage and fuel prices can be adjusted by various assumed rates of increase. A fuel price increase of $.01 per gallon per month could be represented by putting (S6+.01) in S7 and copying the formula down the column.

The template could be consolidated by combining some of the steps, which are illustrated here for clarity. For example, the conversion from overtime hours to overtime wages could be accomplished in one step by replacing O6 with (J6*K6*L6).

DOCUMENTATION: OPERATING BUDGET

Application

This template aids in the development of a detailed, period by period, operating budget.

Use

Background assumptions concerning the amount of service offered, and wage and fuel prices, are used to generate budget amounts for service related line items. Other items are entered as estimated, either on an annual or monthly basis.

Notes

The first 30 rows contain background information provided as assumptions in developing the budget.

Rows 31 through 105 contain budgeted line item amounts by monthly period, and annual total.

Rows 107 through 117 contain summary statistics of budgeted performance.

Columns O through Q contain breakdowns of each line item per hour, per mile, and as a percentage of the total budget.

All items are entered as direct monthly estimates (or annual estimates divided by 12) except as follows:

Rows 6 - 9: Data. Number of days of each type of service offered.

Q6 - Q9: Assumption. Projected hours of service offered on each type of day.

Row 10: Assumption. Projected hours of special service offered, such as express, employee trippers, or other.

C12: (C6*Q6+C7*Q7+C8*Q8+C9*Q9+C10)

C13: (C12*Q13)

Q13: Assumption. System-wide average operating speed, miles per hour.

B15: Avg(C15..N15)

C15: Assumption. Average or effective operator wage rate, taking progression, Cost of living adjustments, and wage increases into account.

Q15: Assumption. Platform hours divided by vehicle hours.

B16: Avg(C16..N16)

C16: Assumption. Average or effective mechanic wage rate, taking progression, job categories, COLA and wage increases into account.

C17: (C33+C35)

Q17: Assumption. Gross wages, including paid absences, divided by wages for time worked by bargaining unit employees.

C18: (C34+C36+C37+C38+C39)

Q18: Assumption. Gross wages, including paid absences, divided by wages for time worked by exempt employees.

B20: Avg(C20..N20)

C20: Assumption. Projected price of fuel in dollars per gallon. An increase of $.0066 per gallon per month is assumed for the example.

Q20: Assumption. Allocation factor for assigning a portion of fixed costs to operations.

C21: (C13/3.14)*C20 The example uses an average fuel mileage of 3.14 miles per gallon.

Q21: Assumption. Allocation factor for assigning a portion of fixed costs to non-operating accounts. Q20 plus Q21 should equal 1.

B22: Avg(C22..N22)

C22: Assumption. Projected price of oil in dollars per quart.

Q22: Assumption. Projected cost of parts in dollars per vehicle mile.

C23: (C13*C22)/109 The example uses an oil mileage rate of 109 miles per quart.

C24: (108*4)*C20. The example has four service vehicles consuming 108 gallons each per month.

B26: Avg(C26..N26)

C26: Assumption. Projected average principal balance of outstanding loans in each period.

C27: Assumption. Projected average monthly interest rate for each period.

B29: Avg(C29..N29)

C29: Assumption. Projected monthly revenue productivity in dollars per vehicle hour.

C33: (C12*C15*Q15)

O33: (B33/B12)

P33: (B33/B13)

Q33: (B33/B108). Set format to percent or multiply by 100.

C34: (13000/Q18). Example uses projected monthly salaries of $13,000.

C35: (C6+C7)*8*24.05*C16/Q17. Example uses 24.05 mechanic equivalents, including overtime, and 8 hour days.

C36: (8200/Q18). Example uses projected monthly salaries of $8,200.

C40: Sum(C33..C39)

C43: ((C17*Q17)+(C18*Q18))*0.067

C44: ((C17*Q17)+(C18*Q18)*0.07

C51: (C17*.008)+(C18*.012) Example uses sick rates of .008 day off per day worked for bargaining unit employees, .012 day off per day worked for exempt employees.

C52: (C17*.033)+(C18*.046)

C53: (C17*.043)+(C18*.05)

C54: (C17*.003)+(C18*.004)

C56: Sum (C43..C55)

C67: Sum (C59..C66)

C70: (C21+C23+C24)+(1.4*C23). Example uses 1.4 x oil cost for lube cost.

C73: (C13*Q22)

C75: Sum (C70..C74)

C85: Sum (C81..C84)

C95: Sum (C91..C94)

C98: (C26*C27)

C103: Sum (C101..C102)

C106: (C40+C56+C67+C75+C78+C85+C88+C95+C98+C103)

C107: (C12*C29)

C108: (C106-C107)

C110: (C106/C12)

C111: (C106/C13)

C112: (C107/C13)

C113: (C107/C106)

C114: (C107/.508). Average fare in example is $.508.

C115: (C114/C12)

Variations

The template presented here can be varied to incorporate the expense line items, accounting periods, and service characteristics applying at each property.

As presented here, system-wide averages are used for operating speed, revenue productivity, parts costs, and other assumptions. These could be broken down by type of service if desired, or included as monthly background data, permitting variations by period.

	A	B	C	D	E	F	G	H
1								OPERATING BUDGET:1984
3		TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
5	BACKGROUND DATA							
	WEEKDAYS, SCHOOL	200	21	20	23	21	21	18
7	WEEKDAYS,NO SCHOOL	55	0	0	0	0	0	4
	SATURDAYS	53	5	4	4	5	4	4
9	SUNDAYS,HOLIDAYS	57	5	4	4	4	6	4
	SPEC.SVCE, VEH HRS	1560	130	130	130	130	130	130
11								
	VEH HRS,TOT	154272	13238	12226	13735	13073	13059	13000
13	VEH MI,TOT	1743274	149589	138154	155206	147725	147567	146900
15	OPER RATE,EFF	8.94	8.49	8.64	8.64	8.64	8.74	8.74
	MECH RATE,EFF	8.78	8.02	8.22	8.22	8.22	8.89	8.89
17	WAGES,HRS WKD,BU	1945237	156516	149520	164383	157863	164563	163962
	WAGES,HRS WKD,EXEMPT	457586	38132	38132	38132	38132	38132	38132
19								
	FUEL UNIT PRICE	1.14	$1.10	$1.11	$1.11	$1.12	$1.13	$1.13
21	FUEL COST	630781	52404	48688	55024	52682	52936	53006
	OIL UNIT PRICE	0.78	$0.71	$0.72	$0.74	$0.75	$0.76	$0.77
23	OIL COST	12403	980	918	1047	1012	1026	1036
	SVC VEH FUEL	5891	475	478	481	484	487	489
25								
	AVG PRIN BAL	291588	291588	291588	291588	291588	291588	291588
27	INT RATE	0.152	0.013	0.013	0.013	0.013	0.013	0.013
29	REV PRODUCTIVITY	13.72	13.76	12.98	13.26	13.55	13.74	13.74
31								

Figure 10.5 Operating Budget

	I	J	K	L	M	N	O	P	Q
1									
3	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER			
5								CONSTANTS	
	0	0	20	21	19	16	VEH HOURS:		503
7	20	23	1	0	2	5			445
	5	4	4	5	4	5			344
9	6	4	5	5	5	5			165
	130	130	130	130	130	130			
11									
	11740	12401	12836	13238	12778	12948			
13	132662	140131	145047	149589	144391	146312	AVE. SPEED:		11.3
15	8.94	9.15	9.15	9.15	9.15	9.46	PLAT/VEH HRS		1.140
	8.89	9.15	9.15	9.15	9.15	9.46			
17	151120	161746	166283	170477	165678	173125	HRS PD/HRS WKD.BU		1.097
	38132	38132	38132	38132	38132	38132	HRS PD/HRS WKD.SAL		1.112
19									
	$1.14	$1.15	$1.15	$1.16	$1.17	$1.17	ALLOC FACT, OPS		0.884
21	48147	51152	53252	55234	53618	54639	ALLOC FACT, NON-OP		0.116
	$0.78	$0.79	$0.80	$0.82	$0.83	$0.84	PARTS COST PER MIL		0.07
23	950	1018	1070	1120	1097	1129			
	492	495	498	501	504	507			
25									
	291588	291588	291588	291588	291588	291588			
27	0.013	0.013	0.013	0.013	0.013	0.013			
29	13.76	12.49	13.69	14.80	15.21	13.67			
31									

	A	B	C	D	E	F	G	H
							OPERATING BUDGET:1984	
		TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
31	LINE ITEMS							
	SALARIES AND WAGES							
33	50101,010,OPERS	1572083	128125	120421	135284	129764	133092	132491
	50102,010,OP,OTH	140288	11691	11691	11691	11691	11691	11691
35	50102,041,MT,MECHS	373153	28391	29099	29099	29099	31471	31471
	50102,042,MT,ADMIN	88489	7374	7374	7374	7374	7374	7374
37	50102,160,GA,OPS	37047	3087	3087	3087	3087	3087	3087
	50102,160,GA,E.D.	150216	12518	12518	12518	12518	12518	12518
39	50102,160,GA,MKTG	41547	3462	3462	3462	3462	3462	3462
	501 TOTAL LABOR	2402823	194648	187652	202515	195995	202695	202094
41								
	FRINGE BENEFITS							
43	50201,FICA	175762	14240	13730	14813	14338	14826	14782
	50202,RTRMNT	183632	14878	14345	15476	14980	15490	15444
45	50203,HOSP/MED	210600	17100	17100	17100	17100	17100	17100
	50204,DENTAL	12810	1035	1035	1035	1035	1035	1035
47	50205,LIFE/AD&D	8460	705	705	705	705	705	705
	50206,DIS	16500	1375	1375	1375	1375	1375	1375
49	50207,UNEMPL	24924	2077	2077	2077	2077	2077	2077
	50208,WK,CMP	70800	5900	5900	5900	5900	5900	5900
51	50209,SICK LVE	21053	1710	1654	1773	1720	1774	1769
	50210,HOL	85242	6919	6688	7179	6964	7185	7165
53	50211,VAC	107108	8684	8381	9024	8742	9032	9006
	50212,OTH PD ABS	7666	622	601	646	626	646	644
55	50213,UNIFORMS	9792	816	816	816	816	816	816
	502 TOTAL FRINGES	934348	76060	74408	77918	76378	77961	77819
57								
	SERVICES							
59	50302,MKT/PROMO SVCS	3000	250	250	250	250	250	250
	50303,PROF/TECH SVCS	26280	2190	2190	2190	2190	2190	2190
61	50304,TEMP HELP	2640	220	220	220	220	220	220
	50305,MT.CNTR MT SVCS	16320	1360	1360	1360	1360	1360	1360
63	50305,GA.CNTR MT SVCS	3180	265	265	265	265	265	265
	50306,CUST,SVCS	660	55	55	55	55	55	55
65	50307,SECURITY SVCS	4200	350	350	350	350	350	350
	50399,160,OTH SVCS	24000	2000	2000	2000	2000	2000	2000
67	503 TOTAL SVCS	80280	6690	6690	6690	6690	6690	6690

Figure 10.5 Operating Budget (cont'd)

Operating Budget

	I	J	K	L	M	N	O	P	Q
	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER			
							$/HR	$/MI	% OF TOT
33	119649	129355	133892	138086	133287	137636	$10.19	$0.90	34.30
	11691	11691	11691	11691	11691	11691	$0.91	$0.08	3.06
35	31471	32391	32391	32391	32391	33489	$2.42	$0.21	8.14
	7374	7374	7374	7374	7374	7374	$0.57	$0.05	1.93
37	3087	3087	3087	3087	3087	3087	$0.24	$0.02	0.81
	12518	12518	12518	12518	12518	12518	$0.97	$0.09	3.28
39	3462	3462	3462	3462	3462	3462	$0.27	$0.02	0.91
	189252	199878	204416	208609	203811	211257	$15.58	$1.38	52.43
41									
43	13847	14621	14951	15257	14907	15450	$1.14	$0.10	3.84
	14467	15275	15621	15940	15575	16141	$1.19	$0.11	4.01
45	18000	18000	18000	18000	18000	18000	$1.37	$0.12	4.60
	1100	1100	1100	1100	1100	1100	$0.08	$0.01	0.28
47	705	705	705	705	705	705	$0.05	$.00	0.18
	1375	1375	1375	1375	1375	1375	$0.11	$0.01	0.36
49	2077	2077	2077	2077	2077	2077	$0.16	$0.01	0.54
	5900	5900	5900	5900	5900	5900	$0.46	$0.04	1.54
51	1667	1752	1788	1821	1783	1843	$0.14	$0.01	0.46
	6741	7092	7241	7380	7221	7467	$0.55	$0.05	1.86
53	8450	8910	9107	9288	9080	9403	$0.69	$0.06	2.34
	606	638	651	664	650	672	$0.05	$.00	0.17
55	816	816	816	816	816	816	$0.06	$0.01	0.21
	75750	78260	79332	80323	79189	80948	6	1	20
57									
59	250	250	250	250	250	250	$0.02	$.00	0.07
	2190	2190	2190	2190	2190	2190	$0.17	$0.02	0.57
61	220	220	220	220	220	220	$0.02	$.00	0.06
	1360	1360	1360	1360	1360	1360	$0.11	$0.01	0.36
63	265	265	265	265	265	265	$0.02	$.00	0.07
	55	55	55	55	55	55	$.00	$.00	0.01
65	350	350	350	350	350	350	$0.03	$.00	0.09
	2000	2000	2000	2000	2000	2000	$0.16	$0.01	0.52
67	6690	6690	6690	6690	6690	6690	$0.52	$0.05	1.75

	A	B	C	D	E	F	G	H
								OPERATING BUDGET:1984
		TOTAL	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
69	MATERIALS & SUPPLIES							
	50401,FUEL/LUBS	666439	55230	51370	59018	55594	55884	55982
71	50402,TIRES	72000	6000	6000	6000	6000	6000	6000
	50499,OP,OTH MTLS	11076	923	923	923	923	923	923
73	50499,MT,OTH MTLS	122029	10471	9671	10864	10341	10330	10283
	50499,GA,160,OTH MTLS	19056	1588	1588	1588	1588	1588	1588
75	504 TOTAL MTLS/SUPPLI	890600	74212	69552	77393	74446	74725	74776
77	UTILITIES							
	505 TOTAL UTILS	23340	1945	1945	1945	1945	1945	1945
79	CASUALTY & LIABILITY COSTS							
81	50601,PHYS DAM INS	42900	3575	3575	3575	3575	3575	3575
	50603,LIAB INS	110808	9234	9234	9234	9234	9234	9234
83	50606,DED PAYOUTS	816	68	68	68	68	68	68
	50608,OTH INS	2856	238	238	238	238	238	238
85	506 TOTAL CAS/LIAB	157380	13115	13115	13115	13115	13115	13115
87	TAXES							
	507 TOTAL VEH LIC	120	10	10	10	10	10	10
89	MISCELLANEOUS EXPENSE							
91	50901,DUES/SBSCR	3240	270	270	270	270	270	270
	50902,TRVL	4152	346	346	346	346	346	346
93	50908,ADV/PROMO MEDIA	18480	1540	1540	1540	1540	1540	1540
	50999,OTH DIR	5820	485	485	485	485	485	485
95	509 TOTAL MISC EXP	31692	2641	2641	2641	2641	2641	2641
97	INTEREST EXPENSES							
	511 TOTAL INTEREST	44411	3701	3701	3701	3701	3701	3701
99	LEASES & RENTALS							
101	51210,OP FAC LS	2076	173	173	173	173	173	173
	51212,GA FAC LS/RNTLS	15600	1300	1300	1300	1300	1300	1300
103	512 TOTAL LEASES/RNTL	17676	1473	1473	1473	1473	1473	1473
105	SUMMARY							
	TOTAL EXP	4582671	374496	361187	387402	376394	384456	384264
107	TOTAL REVS	2117595	182155	158693	182126	177139	179431	178620
	OPER DEFICIT	2465076	192341	202493	205276	199255	205025	205644
109								
	EXP/VEH HR	$29.71	$28.29	$29.54	$28.21	$28.79	$29.48	$29.56
111	EXP/VEH MI	$2.63	$2.50	$2.61	$2.50	$2.55	$2.61	$2.62
	REV/VEH MI	$1.21	$1.22	$1.15	$1.17	$1.20	$1.22	$1.22
113	OPER RATIO	0.46	0.49	0.44	0.47	0.47	0.47	0.46
	PAX	4168494	358573	312389	358516	348699	353210	351614
115	PAX/VEH HR	27.0	27.1	25.6	26.1	26.7	27.0	27.0

Figure 10.5 Operating Budget (cont'd)

	I	J	K	L	M	N	O	P	Q
	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER .			
69									
	50919	54092	56318	58423	56755	57954	$4.32	$0.38	14.54
71	6000	6000	6000	6000	6000	6000	$0.47	$0.04	1.87
	923	923	923	923	923	923	$0.07	$0.01	0.24
73	9286	9809	10153	10471	10107	10242	$0.79	$0.07	2.66
	1588	1588	1589	1588	1588	1588	$0.12	$0.01	0.41
75	68716	72412	74982	77405	75374	76607	6	1	19
77									
	1945	1945	1945	1945	1945	1945	$0.15	$0.01	0.51
79									
81	3575	3575	3575	3575	3575	3575	$0.28	$0.02	0.94
	9234	9234	9234	9234	9234	9234	$0.72	$0.06	2.42
83	68	68	68	68	68	68	$0.01	$.00	0.02
	238	238	238	238	238	238	$0.02	$.00	0.06
85	13115	13115	13115	13115	13115	13115	$1.02	$0.09	3.43
87									
	10	10	10	10	10	10	$.00	$.00	.00
89									
91	270	270	270	270	270	270	$0.02	$.00	0.07
	346	346	346	346	346	346	$0.03	$.00	0.09
93	1540	1540	1540	1540	1540	1540	$0.12	$0.01	0.40
	485	485	485	485	485	485	$0.04	$.00	0.13
95	2641	2641	2641	2641	2641	2641	$0.21	$0.02	0.69
97									
	3701	3701	3701	3701	3701	3701	$0.29	$0.02	0.97
99									
101	173	173	173	173	173	173	$0.01	$.00	0.05
	1300	1300	1300	1300	1300	1300	$0.10	$0.01	0.34
103	1473	1473	1473	1473	1473	1473	$0.11	$0.01	0.39
105									
	363294	380126	388305	395912	387949	398388	$29.71	$2.63	100.00
107	161542	154888	175725	195922	194353	176999	$13.73	$1.21	
	201752	225237	212580	199989	193595	221388	$15.98	$1.41	
109									
	$30.94	$30.65	$30.25	$29.91	$30.36	$30.77			
111	$2.74	$2.71	$2.68	$2.65	$2.69	$2.72			
	$1.22	$1.11	$1.21	$1.31	$1.35	$1.21			
113	0.44	0.41	0.45	0.49	0.50	0.44			
	317997	304899	345915	385674	382585	348424			
115	27.1	24.6	26.9	29.1	29.9	26.9			

DOCUMENTATION: BUDGET COMPARISON

Application

This spreadsheet allows a proposed operating budget to be systematically compared with expenditure experience from past years.

Use

Expense experience by category is entered for the last completed budget year, current year budget, and current year total expense estimates, based on year to date data. As revisions are made to the budget proposal, they can be easily compared to past experience.

Assumptions

The example shown here illustrates an agency in which budget items are summarized by area of responsibility.

Notes

Column B: Data. Actual expenditures for the last completed fiscal year.

Column C: Data. Budgeted expenditures for the current fiscal year.

Column D: Data. Estimated actual expenditures for the current fiscal year, based on actual expenditures to date.

Column E: Input Data. Proposed budget for the upcoming fiscal year.

F6: ((D6-B6)/B6)*100

G6: ((E6-D6)/D6)*100

Variations

If the format of line items or expense categories in column A is matched with that of the proposed budget summary, data may be able to be transferred automatically from the budget spreadsheet to this one.

The budgeted line items can be adapted to the budget structure of each agency.

	A	B	C	D	E	F	G
1				Budget Comparisons			
3		Expenditures 1982	Budget 1983	Estimated 1983	Proposed 1984	% Change 1982-1983	% Change 1983-1984
5	General Mgr & Board	206	224	211	211	2.43	0
7	MBE	31	35	35	33	12.90	-5.71
	SUBTOTAL	237	259	246	244	3.80	-0.81
9	Admin & Finance	317	354	314	328	-0.95	4.46
11	Human Resources	325	353	328	366	0.92	11.59
	CIC	191	207	202	233	5.76	15.35
13	Finance	95	115	101	122	6.32	20.79
	Purchasing	172	177	180	198	4.65	10.00
15	Accounting & Payr	131	154	147	166	12.21	12.93
	Cashier & Cust. S	260	271	266	275	2.31	3.38
17	Safety	35	40	37	41	5.71	10.81
	Claims	453	586	446	626	-1.55	40.36
19	SUBTOTAL	1979	2257	2021	2355	2.12	16.53
21	Support Services	113	123	120	132	6.19	10.00
	Service Devel.	587	610	606	683	3.24	12.71
23	MIS	291	373	371	464	27.49	25.07
	Scheduling	83	98	94	121	13.25	28.72
25	SUBTOTAL	1074	1204	1191	1400	10.89	17.55
27	Marketing	565	700	661	653	16.99	-1.21
29	Operations	87	127	102	149	17.24	46.08
	Trans	12974	14730	14553	16016	12.17	10.05
31	Equip	6389	6844	6735	7390	5.42	9.73
	B/G	1278	1406	1252	1541	-2.03	23.08
33	SUBTOTAL	20728	23107	22642	25096	9.23	10.84
35	TOTAL	24583	27527	26761	29748	8.86	11.16
37	SERVICE HOURS	683036	738000	733076	785000	7.33	7.08
39	PASSENGERS(THOU)	16219	16900	16765	17781	3.37	6.06

Figure 10.6 Budget Comparison

DOCUMENTATION: 10-YEAR OPERATING BUDGET

Application

This spreadsheet supports development of a long-term funding and capital acquisition strategy. Alternative assumptions concerning cost forecasts, funding levels and ridership may be tested.

Use

The last complete year's and current year's data are used to generate hourly cost, average fare and productivity rates. These statistics are used as a baseline for projection of service provided, costs, and revenues in the future.

Assumptions

A variety of assumptions concerning addition of service, changes in operating costs per hour, future productivity (in terms) of passengers per hour), future fare policy, and other sources of operating revenue can be incorporated in the formulas used. (See notes, below.) These assumptions allow each year's projection to be built on the statistics for the preceding year.

The example does not include the interrelationships between fare levels and ridership nor that amount of service and productivity.

Notes:

B6: Data. Hours of service provided during previous complete year.

D6: (C10)

B8: Data. Hours of service added since previous year.

PASSENGERS, HOURS, REVENUE & EXPENSE
1983 TO 1993

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
BEGINNING HOURS:	694404	704405	754445	779545	816170	823170	830170	837170	844170	851170	858170
ADDED SERVICE:	10001	50040	25100	36625	7000	7000	7000	7000	7000	7000	7000
TOTAL HOURS:	704405	754445	779545	816170	823170	830170	837170	844170	851170	858170	865170
COST PER HOUR:	33.55	36.49	38.31	40.23	42.24	44.35	46.57	48.90	51.35	53.91	56.61
EXPENSES:	23630269	27527000	29867877	32834703	34772130	36821213	38988275	41279989	43703404	46265961	48975514
PASSENGERS PER HOUR:	23.02	22.22	21.81	21.79	22.55	23.36	24.12	24.12	24.13	24.13	24.14
REVENUE PASSENGERS:	16218629	16765448	17005136	17780673	18562721	19394635	20191005	20364255	20537504	20710754	20884003
AVERAGE FARE:	0.466	0.469	0.5054	0.5054	0.5559	0.5559	0.6115	0.6115	0.6727	0.6727	0.6727
PASSENGER REVENUE:	7557881	7862995	8594396	8986352	10319759	10782253	12347486	12453434	13815320	13931863	14048406
OTHER OPERATING REV:	483779	537000	570000	595000	624000	650000	680000	712000	740000	775000	811000
TOTAL REVENUE:	8041660	8399995	9164396	9581352	10943759	11432253	13027486	13165434	14555320	14706863	14859406
REVENUE/EXPENSE:	34.03%	30.52%	30.68%	29.18%	31.47%	31.05%	33.41%	31.89%	33.30%	31.79%	30.34%

Figure 10.7 10-Year Operating Budget

D8: Assumption. Projected increase in service over previous year.

B10: (B6+B8)

B13: (B16/B10)

D13: Assumption. (C13*1.05) represents a 5 percent annual increase in unit costs.

B16: Data. Actual expenses for last complete fiscal year.

D16: (D10*D13)

B20: (B22/B10)

D20: Assumption. Projected productivity.

B22: Data. Actual passengers for last complete fiscal year.

D22: (D10*D20)

B24: (B26/B22)

D24: Assumption. Projected average fare.

B26: Data. Actual passenger revenues during last complete fiscal year.

D26: (D22*D24)

B28: Data. Actual other revenue during last complete fiscal year.

D28: Assumption. Projected other operating revenue.

B30: (B26+B28)

B32: (B30/B16)*100

Variations:

Numerous assumptions and interrelationships between the variables can be incorporated in this template. Row 8, added service, illustrates an assumption of linear growth after 1978, where a constant amount of service is added each year. Row 13, cost per hour, illustrates exponential increase, where the cost increases by a constant percentage each year. Other formulas can be used for other assumptions, or actual quantities can be assumed.

Ridership reductions due to fare increases could also be incorporated in the template, by incorporating material from Application 10, if the amount of service offered remains constant.

DOCUMENTATION: 10-YEAR CAPITAL BUDGET

Application

This template supports planning of capital expenditures for capital grant applications and obtaining local match.

Use

Capital requirement forecasts by project are input. The template summarizes annual capital expenses.

Notes

All entries are manual projections of capital requirements by project.

CAPITAL EXPENDITURES
1983 TO 1993

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
OPS CAPITAL EXPENSES:											
ADVANCED DSN BUSES:											
99/85/50/50/50/31	13259835	12991973	8200000	8850000	9550000				8029000		
SMALL BUSES(10):			1000000								
FARE COLLECTION SYS:		1100000	20000	51000							
TWO-WAY RADIO SYS:		1727493	35000	86250							
SERVICE VEHICLES:		152000	124000	75000	140000	85000	90000				
MIS EQUIP & SOFTW:		443000	300000	80000							
MISCELLANEOUS:	296119	152000	100000			200000	210000	221970	234844	248935	263871
TOTAL OPS EXPENSE:	13555954	16566466	9779000	9142250	9690000	285000	300000	221970	8263844	248935	263871
CONSTRUCTION CAP EXP:											
SHELTERS (150/50):		900000	320000								
SIGNS (3200):		330000									
BUS GARAGE:		6943110	6481072								
PARK-N-RIDE LOTS:	594516	456000	1000000	1250000							
TOTAL CONSTRUCTION:	594516	8629110	7801072	1250000	0	0	0	0	0	0	0
TOTAL CAP EXPENSES:	14150470	25195576	17580072	10392250	9690000	285000	300000	221970	8263844	248935	263871

Figure 10.8 10-Year Capital Budget

DOCUMENTATION: CASH FLOW PROJECTION

Application

The cash balance can be forecast by week using this template, allowing planning of loans and investments.

Use

Projections of weekly operating revenues, expenses, and operating assistance payments are input in the template. The template calculates the running cash balance, and average for the study period. Projected data may be replaced by actual revenues, expenses, and aid payments as the year progresses to maintain an up-to-date cash management report.

Notes

Column C: Assumption. Projected operating revenues by week.

Column D: Assumption. Projected operating expenses by week.

D3: Assumption. Opening cash balance.

E8: (C8-D8)

Column F: Assumption. Projected federal operating assistance payments.

Column G: Assumption. Projected state operating assistance payments.

Column H: Assumption. Projected local operating assistance payments.

Column I: Input data. Planned loans (positive) and payments (negative).

J8: (D3+E8+F8+G8+H8+I8)

J9: (J8+E9+F9+G9+H9+I9)

J36: Avg(J8...J32)

Variations

Aid payment categories may be replaced by mechanisms applying to each property. A more detailed cash management tool follows.

	A	B	C	D	E	F	G	H	I	J
1					CASH FLOW PROJECTION					
3	Opening Cash Balance:		$ 100000							
5	Week	Week No.	System Revenues	System Expenses	Cash Deficit	Federal Aid	State Aid	Local Loans or Aid Payments		Balance at end of Week
7	Jan. 7	1	25000	70000	-45000			10000		65000
9	Jan. 14	2	25000	44500	-19500			10000		55500
	Jan. 21	3	25000	44500	-19500			10000		46000
11	Jan. 28	4	25000	44500	-19500			10000		36500
	Feb. 4	5	25000	70000	-45000			10000		1500
13	Feb. 11	6	25000	44500	-19500			10000		-8000
	Feb. 18	7	25000	44500	-19500			10000		-17500
15	Feb. 25	8	25000	44500	-19500	250000		10000		223000
	Mar. 4	9	25000	70000	-45000			10000		188000
17	Mar. 11	10	25000	44500	-19500			10000		178500
	Mar. 18	11	25000	44500	-19500			10000		169000
19	Mar. 25	12	25000	44500	-19500			10000		159500
	Apr. 1	13	25000	100000	-75000		250000	10000		344500
21	Apr. 8	14	25000	44500	-19500			10000		335000
	Apr. 15	15	25000	44500	-19500			10000		325500
23	Apr. 22	16	25000	44500	-19500			10000		316000
	Apr. 29	17	25000	44500	-19500			10000		306500
25	May 6	18	25000	70000	-45000			10000		271500
	May 13	19	25000	44500	-19500			10000		262000
27	May 20	20	25000	44500	-19500			10000		252500
	May 27	21	25000	44500	-19500			10000		243000
29	June 3	22	25000	70000	-45000			10000		208000
	June 10	23	25000	44500	-19500			10000		198500
31	June 17	24	25000	44500	-19500			10000		189000
	June 24	25	25000	44500	-19500	250000		10000		429500
33	Total		625000	1295500	-670500	500000	250000	250000	0	
35								Average Cash Balance---		191140

Figure 10.9 Cash Flow Projection

DOCUMENTATION: CASH FLOW MANAGER

Application

Investment decisions may be supported by the detailed cash flow information provided by this template.

Use

Monthly projections of revenues by source, and of both operating and capital expenditures, are input. As the year progresses, actual revenue and expense information may be substituted for projections. This data is used to generate the actual or projected cash balance at the end of each month. Investment decisions can be input to produce data on total investment by month, and revised projections of available cash.

Notes

B5: Data. Beginning cash balance.

C5: (B57)

N5: (B5)

B7: Input data. Investments maturing during month. Includes carry over from the previous year plus current investments from rows 40 to 54.

Rows 10 to 14: Data. Actual or projected revenue per month from various sources.

B17: (B5+B7+B15)

N17: (N5+N7+N15)

Rows 20 to 23: Data. Actual or projected operating expenses per month.

Rows 27 to 32: Data. Actual or projected capital expenses per month.

B35: (B24+B33)

N35: (N24+N33)

B37: (B17-B35)

N37: (N17-N35)

Rows 40 to 54: Input data. Amount of investments made in each month. Amounts entered here should also be included in the total investments maturing (Row 7) for the month of maturity.

B55: Sum(B40...B54)

B57: (B37-B55)

N57: (B5+N7+N15-N35-N55)

B60: (2566000-B7+B55). Example uses starting investment balance of $2,566,000.

C60: (B60-C7+C55)

Variations

A simpler cash management tool is shown in the previous example.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	CASH FLOW PROJECTIONS- 1984													
3		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
5	CASH BEG MO*****	-271688	1723	29899	-73260	53391	51449	33162	-37170	72462	536892	1588762	1457762	-271688
7	INVEST MATURE	550000	1065000	716000	874000	735000	445000	430000	239000	746000	704000	150000	595000	7249000
9	REVENUE													
	DEPOSITORY	25954			60000		91000	25000	30000	30000	30000	30000	30000	351954
11	INTEREST	12234	31730	12086	21058	27903	9736	8514	6894	19430	33172	20000	25300	228057
	SALES TAX		814673		637094		644895		736512		615698		650292	4099164
13	FED GRANTS	11306	5193											16499
	OTHER	1241	352						93000					94593
15	TOTAL REVENUE***	50735	851948	12086	718152	27903	745631	33514	866406	49430	678870	50000	705592	4790267
17	TOTAL CASH AVAI*	329047	1918671	757985	1518892	816294	1242080	496676	1068236	867892	1919762	1788762	2758354	11767579
19	OUTLAYS-EXPENSE													
	PAYROLL	138572	136499	135785	132681	137742	142838	148611	140000	140000	140000	140000	140000	1672728
21	A/P OTHER	143752	168965	197756	174345	186794	151396	179400	151862	160000	160000	160000	160000	1994270
	DIAL-A-RIDE	45000	20000	36000	41000		25000	25000	30000	30000	30000	30000	30000	342000
23	OTHER												93000	93000
	SUB TOTAL*******	327324	325464	369541	348026	324536	319234	353011	321862	330000	330000	330000	423000	4101998
25	OUTLAYS-CAPITAL													
27	20 PASS BUS													0
	40 FT BUSES								372912					372912
29	VAN POOL		82946	14329	1856	28252	107	27811						155301
	SHOP EQUIP			724			104	1219						2047
31	E&H BUSES		107362											107362
	MISC OFF EQUIP			1651	619	1057	473	1805	1000	1000	1000	1000	1000	10605
33	SUB TOTAL*******	0	190308	16704	2475	29309	684	30835	373912	1000	1000	1000	1000	646227
35	TOTAL OUTLAYS***	327324	515772	386245	350501	353845	319918	383846	695774	331000	331000	331000	424000	4750225
37	PROJ CASH BAL***	1723	1402899	371740	1168391	462449	922162	112830	372462	536892	1588762	1457762	2334354	7017354

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
39	INVEST DECISIONS													
	2/22 TO 3/23		380000											
41	2/28 TO 5/24		734000											
	2/28 TO 4/26		259000											
43	3/23 TO 6/22			445000										
	4/26 TO 8/23				239000									
45	4/29 TO 7/26				430000									
	4/29 TO 9/20				446000									
47	5/24 TO 10/25					411000								
	6/22 TO 10/25						294000							
49	6/30 TO 12/25						595000							
	7/29 TO 11/30							150000						
51	8/31 TO 9/30								300000					
	.													
53	.													
	.													
55	TOTAL INVEST****	0	1373000	445000	1115000	411000	889000	150000	300000	0	0	0	0	4663000

57	END BALANCE*****	1723	29899	-73260	53391	51449	33162	-37170	72462	536892	1588762	1457762	2334354	2334354
59	CUM INVEST													
	BEG BAL 2566000*	2016000	2324000	2053000	2294000	1970000	2414000	2134000	2195000	1449000	745000	595000	0	-2566000
61	==========													

Figure 10.10 Cash Flow Manager

DOCUMENTATION: FARE STRUCTURE ANALYSIS

Application

This spreadsheet calculates a new fare level to generate a target amount of fare revenue, taking into account loss of ridership due to the fare increase. It also allows the user to project the revenue and ridership generated by a given fare structure.

Use

The current fares and ridership of each fare type are entered in the template, along with a target level of total revenue generation. The template uses successive calculations to calculate new fares which approach the target revenue amount. Since the calculated fares are likely to be uneven numbers, the user can then enter a new fare structure based on the "optimal fares" to test its effect on revenue and ridership.

The spreadsheet can be used to test various fare levels and fare structures in order to identify a combination of fare level and fare structure which minimizes ridership loss, while generating the desired level of revenue.

Assumptions

The fares in all zones are based on some relationship with the base fare in zone 1. In the example shown, the ratio between the various zone fares was maintained: all zone fares were increased by the same percentage.

The model uses the Simpson-Curtin rule to calculate ridership loss due to the fare increase: for every 3% fare increase 1% of riders will be lost.

Notes

General: The model uses successive recalculations to calculate fares approaching the desired level of revenue. For this reason the spreadsheet should be set to recalculate manually.

Note the instructions to users included in lines 34 to 40.

B6: Input data. Current fare for zone 1 in cents.

B28: (B6)

	A	B	C	D	E	F	G	H	I	J	K	L
1					FARE REVENUE PROJECTION PROGRAM							
3	ZONE	1980 FARE	BRTA PASS	EXIST REVS	TEST FARE	TEST PASS	TEST REVS	ELAST FACT	FARE ADJ	NEW FARE	NEW PASS	NEW REVS
5												
7	1	30	651436	195431	36.15	607348	219572	0.93	-0.0105	35	615607	215462
	2	50	158972	79486	60.25	148213	89305	0.93		60	148480	89088
9	3	70	39698	27789	84.36	37011	31221	0.93		90	35955	32360
	4	90	6670	6003	108.46	6219	6745	0.93		110	6181	6799
	5	110	9970	10967	132.56	9295	12322	0.93		130	9372	12183
11	6	130	138	179	156.66	129	202	0.93		160	127	204
	7	150	8	12	180.76	7	13	0.93		180	7	13
13	E&H											
	1	15	158210	23732	18.08	147503	26663	0.93		20	140907	28161
15	2	25	32470	8118	30.13	30273	9120	0.93		30	30327	9098
	3	35	7626	2669	42.18	7110	2999	0.93		40	7266	2907
17	4	45	978	440	54.23	912	494	0.93		55	906	498
	5	55	1882	1035	66.28	1755	1163	0.93		65	1769	1150
19	6	65	90	59	78.33	84	66	0.93		80	83	67
	7	75	0	0	90.38	0	0	0.93		90	0	0
21												
			1068148	355919	36	995858	399884	399884			996888	397991
23			GOAL-->	400000			-116	1	<--FLAG			
					36							
25												
	RESULTS:											
27												
	AMOUNT	30	1068148	355919	36	995858	399884			35	996888	397991
29	DIFF.					-72290	43965				-71260	42072
	%DIFF					-6.77	12.35				-6.67	11.82
31												
33												
	INSTRUCTIONS:											
35	TO CLEAR PUT 30 IN F6, AND SET FLAG TO 0.											
	ENTER DESIRED REVS IN E23 (GOAL), RECALC UNTIL CLEAR.											
37	PUT +F22 IN F6 & SET FLAG TO 1 TO RUN.											
	RECALC ABOUT 10 TIMES.											
39	ENTER ANY FARES IN COLUMN K FOR NEW PASS AND REVS.											
41												

Figure 10.11 Fare Structure Analysis

C6: Input data. Current annual zone 1 passengers.

C28: (C22)

D6: (B6*C6)/100, in dollars.

D23: Input data. Target revenue objective.

D28: (D22)

E6: Enter current zone 1 fare to set up template.

E7: (E6*(B7/B6)). Example assumes all fares will be increased by same percentage.

E22: (E24-I6)

E24: (E6)

E28: (E6)

F6: (H6*C6)

F28: (F22)

F29: (F28-C28)

F30: (F29/C28)*100

G6: (E6*F6)/100

G23: (G22-D23)*H23

G28: (G22)

G29: (G28-D28)

G30: (G29/D28)*100

H6: (1-(.33*(E6-B6)/B6)). A fare elasticity of .33 is assumed.

H23: 0 to set up template, 1 to run. See instructions.

I6: (E6*G23/D23)

J6: Input data. Proposed new fare for zone 1 in cents.

J28: (J6)

K6: (C6*(1-(.33*(J6-B6)/B6)))

K28: (K22)

K29: (K28-C28)

K30: (K29/C28)*100

L6: (J6*K6/100)

L28: (L22)

L29: (L28-D28)

L30: (L29/D28)*100

To run the spreadsheet follow the instructions in rows 34 to 40.

Variations

Numerous variations can be made to this spreadsheet. The template can be used to test fare structures without the targeting feature by removing columns E through I.

The relationship between the tested zonal fares can be changed to reflect various fare structures. For example, if a fixed increase between zones were desired, E7 would be (E6+25) for a 25 cent increase.

A separate column could be set up with target revenue levels for each zone. Fare adjustments would be calculated for all zones in column I.

Alternative elasticities can also be tested. If certain market segments are felt to be insensitive to fare levels, the elasticity factor in column H could be changed to 1 or the ".33" in the equation in columns H and K could be reduced.

Market segments by type of fare (Student, Elderly and Handicapped, or Adult) could be used instead of zone segments.

DOCUMENTATION: COST TRACKING AND FORECASTING

Application

This template tracks operating cost components allocated to miles and hours of service. A floating average is maintained to smooth out minor monthly fluctuations for use in performance monitoring. This average is also used as a basis for a one year projection of cost components.

Use

Variable cost elements such as operator wages, benefits, fuel, parts, and maintenance costs are allocated to either miles or hours of service. Each month the cost components allocated to each service measure are totaled, and divided by the number of miles or hours of service operated, to obtain an actual allocated variable cost rate. These actual rates are entered in the template, which generates a floating average and one year projection for each rate. The template can also serve as a basis for graphic illustration of cost trends.

Assumptions

This template generates input for a linear model for operating cost projection: Variable operating cost = (Hourly rate * Platform hours) + (Mileage rate * Revenue Miles). The model is easy to develop and use, but not very accurate for projecting variation in costs for small variations in service. It is satisfactory, if used consistently, for monitoring route performance.

The same cost rates are assumed to apply to all routes. Costs might actually vary between routes with significantly different operating characteristics, such as average speed or driving conditions.

A cost increase is assumed in the equations for projected costs. A 5% increase per year is used in this example.

The use of a 12 month average in smoothing monthly variations removes any significant periodic change within the 12 month period. This procedure would not be effective in projecting monthly ridership, where significant changes occur at different seasons of the year.

Notes

B6: Input data. Actual monthly operating costs allocated to hours/ platform hours actually operated.

C6: Input data. Actual monthly operating costs allocated to miles/revenue miles actually operated.

D17: (Sum(B6...B18))/12

	A	B	C	D	E	F	G
1			OPERATING COST ANALYSIS				
3	MONTH,YR.	HOURLY RATE	MILEAGE RATE	12 MO FLOATING AVERAGE PER HOUR	PER MILE	PROJECTED COSTS PER HOUR	PER MILE
5							
7	JAN 82	21.21	1.51				
	FEB 82	21.50	1.65				
9	MAR 82	21.55	1.39				
	APR 82	20.87	1.69				
11	MAY 82	22.14	1.35				
	JUN 82	21.53	1.34				
13	JUL 82	24.05	1.39				
	AUG 82	21.66	1.32				
15	SEP 82	21.95	1.45				
	OCT 82	21.14	1.38				
17	NOV 82	22.88	1.39				
	DEC 82	19.12	1.40	21.63	1.44		
19							
	JAN 83	22.03	1.38	21.70	1.43		
21	FEB 83	23.74	1.48	21.89	1.41		
	MAR 83	21.81	1.49	21.91	1.42		
23	APR 83	21.65	1.45	21.98	1.40		
	MAY 83	22.27	1.38	21.99	1.40		
25	JUN 83	21.55	1.46	21.99	1.41		
	JUL 83	25.58	1.36	22.12	1.41		
27	AUG 83	23.14	1.37	22.24	1.42		
	SEP 83	23.88	1.41	22.40	1.41		
29	OCT 83	22.37	1.52	22.50	1.42		
	NOV 83	22.79	1.50	22.49	1.43		
31	DEC 83	23.87	1.70	22.89	1.46	22.72	1.51
33	JAN 84	24.75	1.61	23.12	1.48	22.79	1.50
	FEB 84					22.98	1.48
35	MAR 84					23.01	1.49
	APR 84					23.07	1.47
37	MAY 84					23.09	1.47
	JUN 84					23.09	1.48
39	JUL 84					23.22	1.48
	AUG 84					23.35	1.49
41	SEP 84					23.52	1.48
	OCT 84					23.63	1.50
43	NOV 84					23.82	1.51
	DEC 84					24.03	1.53
45							

Figure 10.12 Cost Tracking and Forecasting

E17: (Sum(C6...C18))/12

F30: (D17*1.05) A 5% cost increase is assumed in the example.

G30: (E17*1.05) A 5% cost increase is assumed in the example.

Variations

A similar template could be used for tracking long-term trends of any performance measure. It provides a basis for graphic presentation of trends and projections.

DOCUMENTATION: MONTHLY ROUTE SUMMARY

Application

Monthly revenue information can be used to generate ridership and performance statistics by route.

Use

Revenue, revenue miles, and platform hours for the month are input in columns F, G, and H. The spreadsheet generates cost, ridership, and performance statistics by route. Fare classification data by route must be available.

Assumptions

Operating costs are allocated to either hours or miles of service to generate the rates used (G23 and H23). The previous application shows one method of generating operating cost rates. Units used to develop the rates should be consistent with units in columns G and H (e.g., vehicle-miles vs. revenue-miles, etc.)

Notes

Rows 1-19 are the monthly report. Rows 20-35 contain background data used in calculating the figures in the monthly report.

A6: Route name or number.

B6: (E6*B23)

JANUARY MONTHLY ROUTE SUMMARY: AVERAGE WEEKDAY

ROUTE	STUDENTS	E&H	ADULT	TOTAL PASS	TOTAL REVENUE	TOTAL MILES	PLATFORM HOURS	PASS/MILE	OPERATING COST	COST RECOVERY	SUBSIDY PER PASSENGER
1	32	145	2314	2492	1445	750	65.9	3.32	2603	0.555	0.46
2	56	104	3284	3444	2024	488	58.2	7.06	2045	0.990	0.01
3	14	19	278	311	178	238	19.67	1.31	798	0.223	1.99
4	368	742	8942	10052	5735	2968	234.88	3.39	9710	0.591	0.40
5	1088	1113	19958	22159	12744	5656	439	3.92	18306	0.696	0.25
6	183	460	9178	9821	5718	2069	177.85	4.75	7092	0.806	0.14
7	78	480	4555	5113	2908	1815	142.87	2.82	5920	0.491	0.59
8	258	812	5729	6799	3784	2250	170.59	3.02	7190	0.526	0.50
9	222	377	5600	6199	3562	1842	159.03	3.37	6330	0.563	0.45
10	245	846	7939	9030	5115	3203	240.05	2.82	10171	0.503	0.56
TOTAL	2544	5098	67777	75419	43213	21279	1708	3.54	70164	0.616	0.36

ROUTE	STUDENTS	E&H	ADULT		AVE FARE	MILEAGE RATE	HOURLY RATE
1	0.0128	0.0582	0.9289	1	0.5800	1.46	22.89
2	0.0163	0.0302	0.9536	1	0.5877		
3	0.0449	0.0609	0.8942	1	0.5728		
4	0.0366	0.0738	0.8896	1	0.5705		
5	0.0491	0.0502	0.9007	1	0.5751		
6	0.0186	0.0468	0.9345	1	0.5822		
7	0.0153	0.0939	0.8909	1	0.5688		
8	0.0379	0.1194	0.8426	1	0.5566		
9	0.0358	0.0608	0.9034	1	0.5746		
10	0.0271	0.0937	0.8792	1	0.5665		
SUMMARY	0.0337	0.0676	0.8987		0.5730		

Figure 10.13 Monthly Route Summary

B23: Data from on-board fare classification counts. Total passengers paying student fares/total passengers on route 1.

B34: Data from on-board fare classification counts. Total passengers paying student fares/Total passengers.

C6: (E6*C23)

C23: Data. Passengers paying E & H fares/Total passengers on route 1.

C34: Data. Total passengers paying E & H fares/total passengers.

D6: (E6*D23)

D23: Data. Passengers paying adult fares/total passengers on route 1.

E6: (F6/F23)

E23: (B23+C23+D23) Check for value of 1.

F6: Input data. Fare revenues for analysis period for route 1.

F23: (B23*.4)+(C23*.3)+(D23*.6) Example uses fares of 40, 30, and 60 cents respectively for student, E&H and adult fares.

G6: Data. Scheduled monthly revenue miles on route 1.

G23: Data. Operating costs allocated by mile, mileage rate.

H6: Data. Scheduled monthly platform hours on route 1.

H23: Data. Operating costs allocated by hour, hourly rate.

I6: (E6/G6)

I17: (E17/G17)

J6: (G6*G23)+(H6*H23)

K6: (F6/J6)

K17: (F17/J17)

L6: (J6-F6)/E6

L17: (J17-F17)/E17

Variations

This format can be revised to use passenger counts by drivers. Data would be entered directly in columns B, C, and D.

Performance measures can be changed as desired.

DOCUMENTATION: MONTHLY REPORTING SYSTEM WITH MACROS

Application

Report preparation can be simplified for clerical staff by using separate input forms and blank report templates. Macros can be used to facilitate routine procedures. This system requires a spreadsheet program which can transfer data from one spreadsheet to another.

Use

A separate spreadsheet is used to input the required monthly data. A blank template holds the necessary formulas and data. A third spreadsheet accumulates year-to-date data. Additional spreadsheets are used to store each specific report.

Notes

The input sheet spreadsheet contains no formulas, and is used only for entering the monthly data. The blank spreadsheet contains all the formulas and data described in the monthly route summary documentation (see the previous application), except the monthly revenue, miles, and platform hours data. A third spreadsheet, not illustrated, is exactly the same as the blank, except that it contains all the revenue, miles and platform hour data accumulated during the year to date.

To prepare the monthly report:

1. Enter the monthly operating statistics in the Input Sheet spreadsheet, and save it.

2. Retrieve the blank template. Transfer the input data from Input Sheets to columns F, G, and H of the blank spreadsheet. Save it, giving it the name of the month. This is the monthly report. The transferring and saving procedures can be done in one step using a single macro.

3. Retrieve the year to date spreadsheet. Transfer the input data to columns F, G, and H of the spreadsheet, adding them to the existing values in the cells. Save this spreadsheet using the the existing name. This step can also be done using a macro.

4. Other macros can be used to print the required month and year to date reports, and to retrieve the necessary spreadsheets. The entire report preparation can be accomplished by entering the data on the input sheet and then using 7 single letter macro commands.

INPUT SHEET

ROUTE	MONTH REVENUE	MONTH MILES	PLATFORM HOURS
1	36125	18750	1648
2	50600	12200	1455
3	44500	5950	492
4	143375	74200	5872
5	318600	141400	10975
6	142950	51725	4446
7	72700	45375	3572
8	94600	56250	4265
9	89050	46050	3976
10	127875	80075	6001

Figure 10.14 Monthly Reporting System: Input Sheet

MONTHLY ROUTE SUMMARY:

ROUTE	STUDENTS	E&H	ADULT	TOTAL PASS	TOTAL REVENUE	TOTAL MILES	PLATFORM HOURS	PASS/MILE	OPERATING COST	COST RECOVERY	SUBSIDY PER PASSENGER
1	0	0	0	0				ERR	0	ERR	ERR
2	0	0	0	0				ERR	0	ERR	ERR
3	0	0	0	0				ERR	0	ERR	ERR
4	0	0	0	0				ERR	0	ERR	ERR
5	0	0	0	0				ERR	0	ERR	ERR
6	0	0	0	0				ERR	0	ERR	ERR
7	0	0	0	0				ERR	0	ERR	ERR
8	0	0	0	0				ERR	0	ERR	ERR
9	0	0	0	0				ERR	0	ERR	ERR
10	0	0	0	0				ERR	0	ERR	ERR
TOTAL	0	0	0	0	0	0	0	ERR	0	ERR	ERR

ROUTE	STUDENTS	E&H	ADULT	AVE FARE	MILEAGE RATE	HOURLY RATE
1	0.0128	0.0582	0.9289	0.5800	1.46	22.89
2	0.0163	0.0302	0.9536	0.5877		
3	0.0449	0.0609	0.8942	0.5728		
4	0.0366	0.0738	0.8896	0.5705		
5	0.0491	0.0502	0.9007	0.5751		
6	0.0186	0.0468	0.9345	0.5822		
7	0.0153	0.0939	0.8909	0.5688		
8	0.0379	0.1194	0.8426	0.5566		
9	0.0358	0.0608	0.9034	0.5746		
10	0.0271	0.0937	0.8792	0.5665		
SUMMARY	0.0337	0.0676	0.8987	0.5730		

Figure 10.15 Monthly Reporting System: Blank Template

MONTHLY ROUTE SUMMARY: JANUARY

ROUTE	STUDENTS	E&H	ADULT	TOTAL PASS	TOTAL REVENUE	TOTAL MILES	PLATFORM HOURS	PASS/MILE	OPERATING COST	COST RECOVERY	SUBSIDY PER PASSENGER
1	800	3626	57862	62288	36125	18750	1648	3.32	65086	0.555	0.46
2	1400	2599	82101	86099	50600	12200	1455	7.06	51117	0.990	0.01
3	3486	4731	69477	77694	44500	5950	492	13.06	19943	2.231	-0.32
4	9200	18550	223550	251300	143375	74200	5872	3.39	242742	0.591	0.40
5	27202	27830	498951	553982	318600	141400	10975	3.92	457662	0.696	0.25
6	4575	11499	229451	245524	142950	51725	4446	4.75	177293	0.806	0.14
7	1949	11997	113869	127815	72700	45375	3572	2.82	148005	0.491	0.59
8	6449	20296	143220	169964	94600	56250	4265	3.02	179745	0.526	0.50
9	5550	9425	140004	154979	89050	46050	3976	3.37	158238	0.563	0.45
10	6125	21149	198467	225741	127875	80075	6001	2.82	254278	0.503	0.56
TOTAL	66735	131702	1756950	1955388	1120375	531975	42701	3.68	1754109	0.639	0.32

MONTHLY ROUTE SUMMARY: YEAR TO DATE, JANUARY

ROUTE	STUDENTS	E&H	ADULT	TOTAL PASS	TOTAL REVENUE	TOTAL MILES	PLATFORM HOURS	PASS/MILE	OPERATING COST	COST RECOVERY	SUBSIDY PER PASSENGER
1	5601	25380	405034	436016	252875	131250	11533	3.32	455604	0.555	0.46
2	9797	18195	574705	602696	354200	85400	10185	7.06	357819	0.990	0.01
3	24404	33120	486337	543861	311500	41650	3442	13.06	139602	2.231	-0.32
4	64400	129850	1564850	1759100	1003625	519400	41104	3.39	1699195	0.591	0.40
5	190412	194810	3492654	3877876	2230200	989800	76825	3.92	3203632	0.696	0.25
6	32022	80492	1606156	1718670	1000650	362075	31124	4.75	1241052	0.806	0.14
7	13646	83977	797081	894704	508900	317625	25002	2.82	1036034	0.491	0.59
8	45140	142070	1002538	1189748	662200	393750	29853	3.02	1258216	0.526	0.50
9	38851	65977	980028	1084855	623350	322350	27830	3.37	1107665	0.563	0.45
10	42873	148044	1389271	1580188	895125	560525	42009	2.82	1779947	0.503	0.56
TOTAL	467147	921914	12298653	13687714	7842625	3723825	298907	3.68	12278766	0.639	0.32

Figure 10.16 Monthly Reporting System: Sample Reports

DOCUMENTATION: SERVICE VARIANCE TRACKING

Application

Adherence of actual service provided to budgeted and scheduled service levels can be tracked using this template. This method can be used to monitor the effectiveness of service budgeting, scheduling and operations.

Use

Budgeted service measures (hours of miles of service) can be entered in the template at the beginning of the fiscal year. As each monthly period is concluded, the actual amount of service scheduled, and operated (as recorded on fuel tickets) can be entered. The template will then calculate the variation of scheduled from budgeted service, of operated from scheduled service, and of operated from budgeted service.

Notes

General: Note the built-in documentation provided by labels in rows 3 and 7 of this template.

B9: Data. Budgeted service miles from annual operating budget.

C9: Input data. Actual service scheduled for month. Could be obtained from the wage and fuel budget application.

D9: (C9-B9)

E9: (D9/B9)

E22: (D22/B22)

	A	B	C	D	E	F	G	H	I	J
1					MILEAGE REPORT					
3	A	B	C	D	E	F	G	H	I	J
5		BUDGET SCHEDULED MILES	ACTUAL SCHEDULED MILES	SCHEDULED DIFFERENCE	SCHEDULED DIFFERENCE %	TOTAL ACTUAL MILES	OPERATED VARIANCE	OPERATED VARIANCE %	VARIANCE FROM BUDGET	% VARIANCE FROM BUDGET
7				(C-B)	(D/B)	(FUEL TK)	(F-C)	(G/C)	(D+G)	(I/B)
9	JANUARY	149589	147624	-1965	-1.31%	150812	3188	2.16%	1223	0.82%
	FEBRUARY	138154	135972	-2182	-1.58%	138611	2639	1.94%	457	0.33%
11	MARCH	155206	154095	-1111	-0.72%	155975	1880	1.22%	769	0.50%
	APRIL	147725	146726	-999	-0.68%	148027	1301	0.89%	302	0.20%
13	MAY	147567	146608	-959	-0.65%	146937	329	0.22%	-630	-0.43%
	JUNE	146900	145162	-1738	-1.18%	146195	1033	0.71%	-705	-0.48%
15	JULY	138462	136891	-1571	-1.13%	139021	2130	1.56%	559	0.40%
	AUGUST	140131	138889	-1242	-0.89%	139926	1037	0.75%	-205	-0.15%
17	SEPTEMBER	145047	143829	-1218	-0.84%	145892	2063	1.43%	845	0.58%
	OCTOBER	149589	147194	-2395	-1.60%	148920	1726	1.17%	-669	-0.45%
19	NOVEMBER	144391	141935	-2456	-1.70%	143815	1880	1.32%	-576	-0.40%
	DECEMBER	146312	144926	-1386	-0.95%	145813	887	0.61%	-499	-0.34%
21	SUMMARY	1749073	1729851	-19222	-1.10%	1745944	20093	1.16%	871	0.05%
23										

Figure 10.17 Service Variance Tracking

F9: Input data. Actual service operated during month, obtained from fuel tickets.

G9: (F9-C9)

H9: (G9/C9)

H22: (G22/C22)

I9: (D9+G9)

J9: (I9/B9)

J22: (I22/B22)

Variations

A similar report can be prepared for hours of service.

A graphic illustration comparing the budgeted, scheduled, and operated amounts of service can be generated from this spreadsheet.

DOCUMENTATION: RIDE CHECK ANALYSIS*

Application

This template summarizes on-off count data and produces a load profile, passenger-mile statistics, and schedule adherence checks for the trip surveyed. The following application summarizes the data for all trips surveyed on the route.

Use

Background data on the route includes the distance of each bus stop from the route terminal, and scheduled arrival times at each stop. For each trip sampled, time of arrival, boardings, and alightings at each stop are input.

Notes

Column A: Bus stop number.

Column B: Bus stop location or name.

Column C: Data. Bus stop distance from route terminal in miles.

C34: (C32)

D11: (C11-C10)

D37: (H34)

D38: (M34)

RIDE CHECK ANALYSIS

Route: 1-Omni Date: June 18,1984
Direction: Westbound Day: Saturday
Run: 105 Time: 10:40 AM

Stop Number	Bus Stop	Distance (miles) from Term	Distance (miles) btwn Stops	Time frm Terminal (mins) Sched		Time frm Terminal (mins) Obsrv	Pass On	Pass Off	Cum Pass On	Cum Pass Off	Load	Pass-Miles	Speed Sched	Speed Obsrv
1	Third & Kirkwood	0		0			2	0	2	0	2	0		
2	Third & Park	0.2	0.2	0.7	.	0.5	1	0	3	0	3	0.6	17.14	24.00
3	Third & Chatham	0.4	0.2	1.5	.	1.3	3	0	6	0	6	1.2	15.00	15.00
4	Third & Inman	0.6	0.2	2.3	.	2.3	3	0	9	0	9	1.8	15.00	12.00
5	Third & Barnum	0.8	0.2	3.1	.	3.2	2	1	11	1	10	2	15.00	13.33
6	Third & Kossuth	1	0.2	4	.	4.4	3	2	14	3	11	2.2	13.33	10.00
7	Third & Yonge	1.1	0.1	4.4	.	4.8	2	1	16	4	12	1.2	15.00	15.00
8	Yonge & Jordan	1.3	0.2	5.2	.	5.5	1	3	17	7	10	2	15.00	17.14
9	Yonge & Elm	1.4	0.1	5.6	.	5.9	1	2	18	9	9	0.9	15.00	15.00
10	Yonge & Dixwell	1.7	0.3	6.9	.	7.5	2	1	20	10	10	3	13.85	11.25
11	Yonge & Whalley	2	0.3	8.3	.	9	2	0	22	10	12	3.6	12.86	12.00
12	Yonge & Princess	2.2	0.2	9.2	.	10	2	2	24	12	12	2.4	13.33	12.00
13	Yonge & Earl	2.5	0.3	10.6	.	11.8	4	1	28	13	15	4.5	12.86	10.00
14	Yonge & Dundas	2.7	0.2	11.6	+	12.7	3	0	31	13	18	3.6	12.00	13.33
15	Yonge & Bastille	2.9	0.2	12.5	+	13.3	1	1	32	14	18	3.6	13.33	20.00
16	Yonge & Madison	3.2	0.3	13.9	.	14.5	1	2	33	16	17	5.1	12.86	15.00
17	Yonge & Main	3.4	0.2	14.8	.	15.5	2	0	35	16	19	3.8	13.33	12.00
18	Main & Bloor	3.8	0.4	16.7	.	17.3	1	1	36	17	19	7.6	12.63	13.33
19	Main & Derby	4.1	0.3	18.1	.	18.5	0	1	36	18	18	5.4	12.86	15.00
20	Main & Hawthorne	4.3	0.2	19	.	19.3	0	0	36	18	18	3.6	13.33	15.00
21	Main & Everett	4.7	0.4	21	.	21	0	1	36	19	17	6.8	12.00	14.12
22	Main & Dumbarton	4.9	0.2	21.9	.	21.8	0	4	36	23	13	2.6	13.33	15.00
23	Main & McBeath	5.2	0.3	23.4	.	23.6	0	13	36	36	0	0	12.00	10.00
Total		5.2		23.4		23.6	36	36	36	36		67.5	13.33	13.22

SUMMARY:

Passengers	36	Maximum Load	19
Passenger-Miles	67.5	Average Trip Leng	1.875

LOAD PROFILE Route: 1-Omni

Avge Load	20	40	60
2	+		
3	+		
6	+++		
9	++++		
10	+++++		
11	+++++		
12	++++++		
10	+++++		
9	++++		
10	+++++		
12	++++++		
12	++++++		
15	+++++++		
18	+++++++++		
18	+++++++++		
17	++++++++		
19	+++++++++		
19	+++++++++		
18	+++++++++		
18	+++++++++		
17	++++++++		
13	++++++		
0	.		

Figure 10.18 Ride Check Analysis

Column E: Data. Scheduled travel time from trip start to each stop in minutes.

E34: (E32)

Column G: Input data. Observed travel time from trip start on surveyed trip in minutes.

G34: (G32)

F13: If (Abs(G13-E13)>1), then 1, else 0. Set format to graphic. Uses graphics format to mark those route segments with actual arrival time more than 1 minute different from the scheduled arrival time.

Column H: Data. Passenger boardings by stop.

Column I: Data. Passenger alightings by stop.

J10: (H10)

J11: (J10+H11)

J34: (J32)

J37: Max(L12...L32)

J38: (D38/D37)

K10: (I10)

K11: (K10+I11)

K34: (K32). Usually should equal J34.

L10: (J10-K10)

M10: 0

M11: (L10*D11)

N11: ((C11-C10)/(E11-E10))*60

N34: (C34/E34)*60

O11: ((C11-C10)/G11-G10))*60

O34: (C34/G34)*60

Q10: (L10)

R10: (L10/2). Set graphics format. Set column width to 10.

S10: (L10-20)/2. Set graphics format. Set column width to 10.

T10: (L10-40)/2. Set graphics format. Set column width to 10.

Variations

A column to calculate passenger minutes could be provided.

*adapted from Robert Chapleau and Karsten G. Baass, "Use of SuperCalc to Compute and Report Statistics in Public Transportation," paper presented at the Annual Meeting of the Transportation Research Board, Washington, January 1984.

DOCUMENTATION: RIDE CHECK SUMMARY

Application

Summarizes on-off count data for a number of on-off counts.

Use

On-off count data from a form such as the Ride Check Analysis can be accumulated and expanded to provide a ridership profile for the route.

Assumptions

The use of an expansion factor assumes that the sample of trips surveyed is random, and represents the same distribution of boardings and alightings as occurs throughout the study period.

Notes

Columns A though E are the same as corresponding columns in the Ride Check Analysis.

E3: Number of trips sampled and accumulated in the summary tempate.

D37: (H34*J3)

D38: (K34*J3)

F11: If (Abs(E10-(G11/E3))>1), then 1, else 0. Set to graphic format.

Columns G, H and I are initially set at 0, and accumulate data transferred from columns G, H, and I of the individual trip analyses.

RIDE CHECK SUMMARY Route: 1-Omni Day: Saturday
Direction: Westboun Sched. trips: 22
Trips checked: 3 Exp Fact: 7.333

Stop Number	Bus Stop	Distance (miles) from Term	Distance (miles) btwn Stops	Time frm Terminal (mins) Sched		Time frm Terminal (mins) Obsrv	Total Pass On	Total Pass Off	Avge Load	Total Pass-Miles	Speed Sched	Speed Obsrv Avge
1	Third & Kirkwood	0		0			5	0	1.67	0.00		
2	Third & Park	0.2	0.2	0.7	.	1.5	6	0	3.67	0.33	17.14	24.00
3	Third & Chatham	0.4	0.2	1.5	.	3.9	8	0	6.33	0.73	15.00	15.00
4	Third & Inman	0.6	0.2	2.3	.	6.9	6	0	8.33	1.27	15.00	12.00
5	Third & Barnum	0.8	0.2	3.1	.	9.6	7	2	10.00	1.67	15.00	13.33
6	Third & Kossuth	1	0.2	4	.	13.2	7	5	10.67	2.00	13.33	10.00
7	Third & Yonge	1.1	0.1	4.4	.	14.4	6	4	11.33	1.07	15.00	15.00
8	Yonge & Jordan	1.3	0.2	5.2	.	16.5	4	9	9.67	2.27	15.00	17.14
9	Yonge & Elm	1.4	0.1	5.6	.	17.7	2	5	8.67	0.97	15.00	15.00
10	Yonge & Dixwell	1.7	0.3	6.9	.	22.5	7	4	9.67	2.60	13.85	11.25
11	Yonge & Whalley	2	0.3	8.3	.	27	5	1	11.00	2.90	12.86	12.00
12	Yonge & Princess	2.2	0.2	9.2	.	30	5	4	11.33	2.20	13.33	12.00
13	Yonge & Earl	2.5	0.3	10.6	+	35.4	12	3	14.33	3.40	12.86	10.00
14	Yonge & Dundas	2.7	0.2	11.6	+	38.1	8	1	16.67	2.87	12.00	13.33
15	Yonge & Bastille	2.9	0.2	12.5	.	39.9	3	4	16.33	3.33	13.33	20.00
16	Yonge & Madison	3.2	0.3	13.9	.	43.5	4	4	16.33	4.90	12.86	15.00
17	Yonge & Main	3.4	0.2	14.8	.	46.5	5	0	18.00	3.27	13.33	12.00
18	Main & Bloor	3.8	0.4	16.7	.	51.9	2	4	17.33	7.20	12.63	13.33
19	Main & Derby	4.1	0.3	18.1	.	55.5	1	6	15.67	5.20	12.86	15.00
20	Main & Hawthorne	4.3	0.2	19	.	57.9	0	0	15.67	3.13	13.33	15.00
21	Main & Everett	4.7	0.4	21	.	63	0	3	14.67	6.27	12.00	14.12
22	Main & Dumbarton	4.9	0.2	21.9	.	65.4	0	8	12.00	2.93	13.33	15.00
23	Main & McBeath	5.2	0.3	23.4	.	70.8	0	36	.00	3.60	12.00	10.00
Total (Checked trips)		5.2		23.4		70.8	103	103		64.1	13.33	4.406

SUMMARY: EXPANDED STATISTICS

Total Passengers	755.3	Average Pass. per Trip	34.333
Total Passenger-Miles	470.0	Average Trip Length	0.62

LOAD PROFILE Route: 1-Omni

Avge Load	20	40	60
1.66	.		
3.66	+		
6.33	+++		
8.33	++++		
10	+++++		
10.6	+++++		
11.3	+++++		
9.66	++++		
8.66	++++		
9.66	++++		
11	+++++		
11.3	+++++		
14.3	+++++++		
16.6	++++++++		
16.3	++++++++		
16.3	++++++++		
18	+++++++++		
17.3	++++++++		
15.6	+++++++		
15.6	+++++++		
14.6	+++++++		
12	++++++		
.0	.		

Figure 10.19 Ride Check Summary

J2: Number of trips scheduled during the period being examined. This example uses Saturday as a study period. It could be a weekday, a.m. peak, or evening.

J3: (J2/E5) Expansion factor used. In the example it was assumed that 22 trips were operated during the study period of one day.

J10: (H10-I10)/E3)

J11: (J10+(H11-I11)/E3)

K10: 0

K11: K10 + (D11*J10)

K37: (H34/E3)

K38: (D38/D37)

L11: (D11/(E11-E10))*60

M11: (D11*E3/(G11-G10))*60

Columns O, P, Q, and R correspond to columns Q, R, S, and T of the Ride Check Analysis.

DOCUMENTATION: ROUTE EVALUATION

Application

This template permits the evaluation of planned or existing routes by allocating costs and revenues to the route on the basis of service characteristics.

Use

The model requires the development of unit cost by vehicle, hour, or mile of service for each cost element included. The preparation of these unit costs is a major element in the use of this template. The unit costs are then used in formulas to develop the cost of each element allocated to each route. Several summary statistics are calculated.

Assumptions

The model assumes that the same unit costs apply to all routes regardless of the specific characteristics of each one. This assumption should hold fairly well as long as routes with similar characteristics are being compared.

The example shown applies to park and ride express service. The formulas used for generating wait and prep time apply particularly to this type of service in this transit agency.

Notes

Rows 2 through 16 show service characteristics of each route. Rows 18 through 32 show the various cost elements applied to each route. Rows 34 through 48 generate several summary statistics on each route.

B6: Data. Number of buses in service on route A.

C6: Assumption. Projected number of daily riders on route A.

D6: Data. Average fare charged on route A.

E6: (C6*D6)

F6: (E6*260). Example assumes 260 days of service per year.

G6: Data. Daily vehicle miles on route A, including deadhead.

H6: Data. Travel time on route A, including deadhead.

I6: (B6*.33). Example assumes 20 minutes (.33 hour) of wait time per vehicle.

J6: (B6*.25). Example assumes 15 minutes (.25 hour) of prep time per vehicle.

ROUTE EVALUATION: PARK AND RIDE

ROUTE	BUSES	RIDERS	FARE	DAILY REVENUE	ANNUAL REVENUE	VEHICLE MILES	TRAVEL TIME	WAIT TIME	PREP TIME	TOTAL TIME
A	4	520	1.55	806.00	209560	336	16.80	1.32	1.00	19.12
B	11	1000	1.30	1300.00	338000	564	28.20	3.63	2.75	34.58
C	14	1240	1.30	1612.00	419120	814	40.70	4.62	3.50	48.82
D	15	1640	1.30	2132.00	554320	1522	76.10	4.95	3.75	84.80
E	10	880	1.55	1364.00	354640	555	27.75	3.30	2.50	33.55
F	5	440	1.55	682.00	177320	262	13.10	1.65	1.25	16.00
G	3	260	1.30	338.00	87880	137	6.85	0.99	0.75	8.59
H	8	740	1.30	962.00	250120	271	13.55	2.64	2.00	18.19
I	11	1020	1.15	1173.00	304980	401	20.05	3.63	2.75	26.43
TOTAL	81	7740	12.30	10369.00	2695940	4862	243.10	26.77	20.25	290.08

ROUTE	WAGES	FRINGE BENEFS	PARTS INVENTRY	MAINT	FUEL	TIRES	INSUR	ADMIN OVERHD
A	195.98	80.35	39.00	225.12	77.03	9.41	44.76	201.55
B	354.45	145.32	107.25	377.88	129.30	15.79	75.46	341.62
C	500.41	205.17	136.50	545.38	186.61	22.79	108.91	511.73
D	869.20	356.37	146.25	1019.74	348.92	42.62	203.64	956.02
E	343.89	140.99	97.50	371.85	127.23	15.54	74.26	351.38
F	164.00	67.24	48.75	175.54	60.06	7.34	35.06	167.40
G	88.05	36.10	29.25	91.79	31.41	3.84	18.33	89.61
H	186.45	76.44	78.00	181.57	62.13	7.59	36.26	139.33
I	270.91	111.07	107.25	268.67	91.93	11.23	53.63	274.41
TOTAL	2973.32	1219.06	789.75	3257.54	1114.61	136.14	650.54	3042.29

ROUTE	DAILY COST	RECOVERY RATIO	ANNUAL COST	NET
A	973.40	0.92	227083	-17523
B	1567.08	0.83	407442	-69442
C	2217.50	0.72	576549	-157429
D	3892.76	0.55	1009518	-455198
E	1522.64	0.90	395887	-41247
F	725.38	0.94	188599	-11279
G	388.39	0.87	100981	-13101
H	816.97	1.18	212411	37709
I	1189.12	0.99	309172	-4192
TOTAL	13183.24	7.90	3427643	-731703

Figure 10.20 Route Evaluation

K6: (H6+I6+J6)

B22: (K6*10.25). Example assumes wage rate of $10.25 per hour.

C22: (B22*.41). Example assumes 41% fringe rate.

D22: (B6*9.75). Example assumes parts inventory cost of $9.75 per vehicle per day.

E22: (G6*.67). Example assumes maintenance costs of $.67 per vehicle mile.

F22: ((G6/4)*.917). Example assumes fuel mileage of 4 miles per gallon, and fuel price of $.917 per gallon.

G22: (G6*.028). Example assumes tire cost of 2.8 cents per vehicle mile.

H22: (G6*.1338). Example assumes insurance cost of $.1338 per vehicle mile.

I22: (Sum(B22..H22))*.3. Example assumes administrative overhead as 30% of the total direct costs.

B38: Sum(B22..I22)

C38: (E6/B38)

D38: (B38*260). Example assumes 260 days of service per year.

E38: (F6-D38)

Variations

The example could be restructured to incorporate other assumptions as to the cost structure to be used, the service characteristics of the routes being evaluated, and the actual unit costs, as required by the specific circumstances.

Other performance measures, such as net cost per passenger, could be included.

DOCUMENTATION: SCHEDULE BUILDER A

Application

Headways during each period of the day and travel times are used to build a schedule from the starting time of the first trip in the morning.

Use

Input data consists of headways by time of day, travel times between checkpoints on the route, and the service starting time. The template uses an "if" statement to convert from decimal hours to a 60-minute hour. A "lookup" function is used to identify the appropriate headways between trips.

Notes

The times shown in the schedule are in hours and minutes. The two digits to the right of the decimal point represent minutes.

Columns A and B are a lookup table to determine the appropriate headway for each time period.

A5: Data. Start of time period 1.

B5: Data. Headway during time period 1.

B11: Start of first trip.

C8: Lookup (F7, A5...A9, 1 column over)

F7: (B11)

F8: If ((F7+C8)-Int(F7+C8)>.595) then (F7+C8+.4), else (F7+C8)

G3: Data. Travel time between the first two time points. "0.06" represents 6 minutes.

G7: If ((F7+G3)-Int(F7+G3)>.595) then (F7+G3+.4), else (F7+G3)

F40: If (Int (F7)>12) then (F7-12), else (F7)

Variations

See the following example for a block-based strategy.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1																		
	HEADWAY TABLE		ROUTE 11-CENTRAL AVE.															
3																		
	START OF				TRAVEL TIME----		0.06	0.04	0.05	0.04	0.06		0.05	0.06	0.04	0.05	0.04	0.06
5	TIME PERIOD	HEADWAY				State & Madison	State & Cardinal	State & Central	Central & Allen	Central & Eagle	Central & Jasmin		Central & Jasmin	Central & Eagle	Central & Allen	State & Central	State & Cardinal	State & Madison
	0.00	1.00																
7	6.00	0.20	HEADWAY															
	8.00	0.40				4.00	4.06	4.10	4.15	4.19	4.25		4.30	4.36	4.40	4.45	4.49	4.55
9	15.00	0.20	1.00			5.00	5.06	5.10	5.15	5.19	5.25		5.30	5.36	5.40	5.45	5.49	5.55
	18.00	6.00	1.00			6.00	6.06	6.10	6.15	6.19	6.25		6.30	6.36	6.40	6.45	6.49	6.55
11			0.20			6.20	6.26	6.30	6.35	6.39	6.45		6.50	6.56	6.60	7.05	7.09	7.15
	START TRIP:	4.00	0.20			6.40	6.46	6.50	6.55	6.59	7.05		7.10	7.16	7.20	7.25	7.29	7.35
13			0.20			7.00	7.06	7.10	7.15	7.19	7.25		7.30	7.36	7.40	7.45	7.49	7.55
			0.20			7.20	7.26	7.30	7.35	7.39	7.45		7.50	7.56	7.60	8.05	8.09	8.15
15			0.20			7.40	7.46	7.50	7.55	7.59	8.05		8.10	8.16	8.20	8.25	8.29	8.35
			0.20			8.00	8.06	8.10	8.15	8.19	8.25		8.30	8.36	8.40	8.45	8.49	8.55
17			0.40			8.40	8.46	8.50	8.55	8.59	9.05		9.10	9.16	9.20	9.25	9.29	9.35
			0.40			9.20	9.26	9.30	9.35	9.39	9.45		9.50	9.56	10.00	10.05	10.09	10.15
19			0.40			10.00	10.06	10.10	10.15	10.19	10.25		10.30	10.36	10.40	10.45	10.49	10.55
			0.40			10.40	10.46	10.50	10.55	10.59	11.05		11.10	11.16	11.20	11.25	11.29	11.35
21			0.40			11.20	11.26	11.30	11.35	11.39	11.45		11.50	11.56	12.00	12.05	12.09	12.15
			0.40			12.00	12.06	12.10	12.15	12.19	12.25		12.30	12.36	12.40	12.45	12.49	12.55
23			0.40			12.40	12.46	12.50	12.55	12.59	13.05		13.10	13.16	13.20	13.25	13.29	13.35
			0.40			13.20	13.26	13.30	13.35	13.39	13.45		13.50	13.56	14.00	14.05	14.09	14.15
25			0.40			14.00	14.06	14.10	14.15	14.19	14.25		14.30	14.36	14.40	14.45	14.49	14.55
			0.40			14.40	14.46	14.50	14.55	14.59	15.05		15.10	15.16	15.20	15.25	15.29	15.35
27			0.40			15.20	15.26	15.30	15.35	15.39	15.45		15.50	15.56	16.00	16.05	16.09	16.15
			0.20			15.40	15.46	15.50	15.55	15.59	16.05		16.10	16.16	16.20	16.25	16.29	16.35
29			0.20			16.00	16.06	16.10	16.15	16.19	16.25		16.30	16.36	16.40	16.45	16.49	16.55
			0.20			16.20	16.26	16.30	16.35	16.39	16.45		16.50	16.56	17.00	17.05	17.09	17.15
31			0.20			16.40	16.46	16.50	16.55	16.59	17.05		17.10	17.16	17.20	17.25	17.29	17.35

	F	G	H	I	J	K	L	M	N	O	P	Q	R
35	ROUTE 11: CENTRAL AVENUE												
37	State & Madison	State & Cardinal	State & Central	Central & Allen	Central & Eagle	Central & Jasmin		Central & Jasmin	Central &Eagle	Central & Allen	State & Central	State & Cardinal	State & Madison
39	4.00	4.06	4.10	4.15	4.19	4.25		4.30	4.36	4.40	4.45	4.49	4.55
41	5.00	5.06	5.10	5.15	5.19	5.25		5.30	5.36	5.40	5.45	5.49	5.55
	6.00	6.06	6.10	6.15	6.19	6.25		6.30	6.36	6.40	6.45	6.49	6.55
43	6.20	6.26	6.30	6.35	6.39	6.45		6.50	6.56	6.60	7.05	7.09	7.15
	6.40	6.46	6.50	6.55	6.59	7.05		7.10	7.16	7.20	7.25	7.29	7.35
45	7.00	7.06	7.10	7.15	7.19	7.25		7.30	7.36	7.40	7.45	7.49	7.55
	7.20	7.26	7.30	7.35	7.39	7.45		7.50	7.56	7.60	8.05	8.09	8.15
47	7.40	7.46	7.50	7.55	7.59	8.05		8.10	8.16	8.20	8.25	8.29	8.35
	8.00	8.06	8.10	8.15	8.19	8.25		8.30	8.36	8.40	8.45	8.49	8.55
49	8.40	8.46	8.50	8.55	8.59	9.05		9.10	9.16	9.20	9.25	9.29	9.35
	9.20	9.26	9.30	9.35	9.39	9.45		9.50	9.56	10.00	10.05	10.09	10.15
51	10.00	10.06	10.10	10.15	10.19	10.25		10.30	10.36	10.40	10.45	10.49	10.55
	10.40	10.46	10.50	10.55	10.59	11.05		11.10	11.16	11.20	11.25	11.29	11.35
53	11.20	11.26	11.30	11.35	11.39	11.45		11.50	11.56	12.00	12.05	12.09	12.15
	12.00	12.06	12.10	12.15	12.19	12.25		12.30	12.36	12.40	12.45	12.49	12.55
55	12.40	12.46	12.50	12.55	12.59	1.05		1.10	1.16	1.20	1.25	1.29	1.35
	1.20	1.26	1.30	1.35	1.39	1.45		1.50	1.56	2.00	2.05	2.09	2.15
57	2.00	2.06	2.10	2.15	2.19	2.25		2.30	2.36	2.40	2.45	2.49	2.55
	2.40	2.46	2.50	2.55	2.59	3.05		3.10	3.16	3.20	3.25	3.29	3.35
59	3.20	3.26	3.30	3.35	3.39	3.45		3.50	3.56	4.00	4.05	4.09	4.15
	3.40	3.46	3.50	3.55	3.59	4.05		4.10	4.16	4.20	4.25	4.29	4.35
61	4.00	4.06	4.10	4.15	4.19	4.25		4.30	4.36	4.40	4.45	4.49	4.55
	4.20	4.26	4.30	4.35	4.39	4.45		4.50	4.56	5.00	5.05	5.09	5.15
63	4.40	4.46	4.50	4.55	4.59	5.05		5.10	5.16	5.20	5.25	5.29	5.35

Figure 10.21 Schedule Builder A

DOCUMENTATION: SCHEDULE BUILDER B

Application

Trains or blocks operated by each bus are built from starting, travel, and layover times.

Use

Input data consists of travel times between checkpoints on the route, and service starting time. The template can be adapted to the number of buses required on the route. Military times are converted to clock time as on Schedule Builder A.

Assumptions

Uniform travel and layover times are used throughout the day. The example shows a route served by two vehicles.

Notes

The times shown in the schedule are in hours and minutes as in Schedule Builder A.

A7: First train or block number.

A8: Second train or block number.

A9: (A7)

A10: (A8)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	ROUTE 11-CENTRAL AVE.													
3	TRAVEL	0.06	0.04	0.05	0.04	0.06	0.05		0.06	0.04	0.05	0.04	0.06	0.05
5	TIME	State & Madison	State & Cardinal	State & Central	Central & Allen	Central & Eagle	Central & Jasmin		Central & Jasmin	Central & Eagle	Central & Allen	State & Central	State & Cardinal	State & Madison
7	BLOCK NO.													
	1.00	4.00	4.06	4.10	4.15	4.19	4.25		4.30	4.36	4.40	4.45	4.49	4.55
	2.00	4.30	4.36	4.40	4.45	4.49	4.55		5.00	5.06	5.10	5.15	5.19	5.25
9	1.00	5.00	5.06	5.10	5.15	5.19	5.25		5.30	5.36	5.40	5.45	5.49	5.55
	2.00	5.30	5.36	5.40	5.45	5.49	5.55		6.00	6.06	6.10	6.15	6.19	6.25
11	1.00	6.00	6.06	6.10	6.15	6.19	6.25		6.30	6.36	6.40	6.45	6.49	6.55
	2.00	6.30	6.36	6.40	6.45	6.49	6.55		7.00	7.06	7.10	7.15	7.19	7.25
13	1.00	7.00	7.06	7.10	7.15	7.19	7.25		7.30	7.36	7.40	7.45	7.49	7.55
	2.00	7.30	7.36	7.40	7.45	7.49	7.55		8.00	8.06	8.10	8.15	8.19	8.25
15	1.00	8.00	8.06	8.10	8.15	8.19	8.25		8.30	8.36	8.40	8.45	8.49	8.55
	2.00	8.30	8.36	8.40	8.45	8.49	8.55		9.00	9.06	9.10	9.15	9.19	9.25
17	1.00	9.00	9.06	9.10	9.15	9.19	9.25		9.30	9.36	9.40	9.45	9.49	9.55
	2.00	9.30	9.36	9.40	9.45	9.49	9.55		10.00	10.06	10.10	10.15	10.19	10.25
19	1.00	10.00	10.06	10.10	10.15	10.19	10.25		10.30	10.36	10.40	10.45	10.49	10.55
	2.00	10.30	10.36	10.40	10.45	10.49	10.55		11.00	11.06	11.10	11.15	11.19	11.25
21	1.00	11.00	11.06	11.10	11.15	11.19	11.25		11.30	11.36	11.40	11.45	11.49	11.55
	2.00	11.30	11.36	11.40	11.45	11.49	11.55		12.00	12.06	12.10	12.15	12.19	12.25
23	1.00	12.00	12.06	12.10	12.15	12.19	12.25		12.30	12.36	12.40	12.45	12.49	12.55
	2.00	12.30	12.36	12.40	12.45	12.49	12.55		13.00	13.06	13.10	13.15	13.19	13.25
25	1.00	13.00	13.06	13.10	13.15	13.19	13.25		13.30	13.36	13.40	13.45	13.49	13.55
	2.00	13.30	13.36	13.40	13.45	13.49	13.55		14.00	14.06	14.10	14.15	14.19	14.25
27	1.00	14.00	14.06	14.10	14.15	14.19	14.25		14.30	14.36	14.40	14.45	14.49	14.55
	2.00	14.30	14.36	14.40	14.45	14.49	14.55		15.00	15.06	15.10	15.15	15.19	15.25
29	1.00	15.00	15.06	15.10	15.15	15.19	15.25		15.30	15.36	15.40	15.45	15.49	15.55
	2.00	15.30	15.36	15.40	15.45	15.49	15.55		16.00	16.06	16.10	16.15	16.19	16.25
31														

Figure 10.22 Schedule Builder B

B3: Data. Travel time in minutes between the first two time points. ".06" represents 6 minutes.

B7: Input data. Starting time of train or block 1.

B8: Input data. Starting time of train or block 2.

B9: If ((N7+N3)-Int(N7+N3)>.595) then (N7+N3+.4), else (N7+N3).

B10: If ((N8+N3)-Int(N8+N3)>.595) then (N8+N3+.4), else (N8+N3).

B37: If (Int(B7)>12), then (B7-12), else (B7).

C7: If((B7+B3)-Int(B7+B3)>.595) then (B7+B3+.4), else (B7+B3)

I7: If ((G7+G3)-Int(G7+G3)>.595) then (G7+G3+.4), else (G7+G3).

J7: If ((I7+I3)-Int(I7+I3)>.595) then (I7+I3+.4), else (I7+I3)

Variations

The template can be adjusted to accommodate additional buses on the route by changing the formulas in column B.

Different travel times for different times of day could be included by using a lookup function, similar to that used for headways in Schedule Builder A.

DOCUMENTATION: RUN SUMMARY

Application

This spreadsheet summarizes the various paid time components of scheduled runs. It can also be used to examine the inpact of work rule changes on a given set of runs. The example illustrates various ways of manipulating clock times.

Use

Information entered for each run includes the run number, route and train (or block), start and finish time of each piece of the run, report time and travel time. Overtime, guarantee spread time and total pay time for each run are calculated by the spreadsheet. Each pay time component is summarized for all the runs entered. All times are given in military time (24-hour clock) for computational purposes.

Assumptions

The work rules governing overtime, guarantee and spread time are incorporated in the formulas of columns AD, AF, and AH. Platform time includes deadhead time.

Notes

A7: Data. Run number.

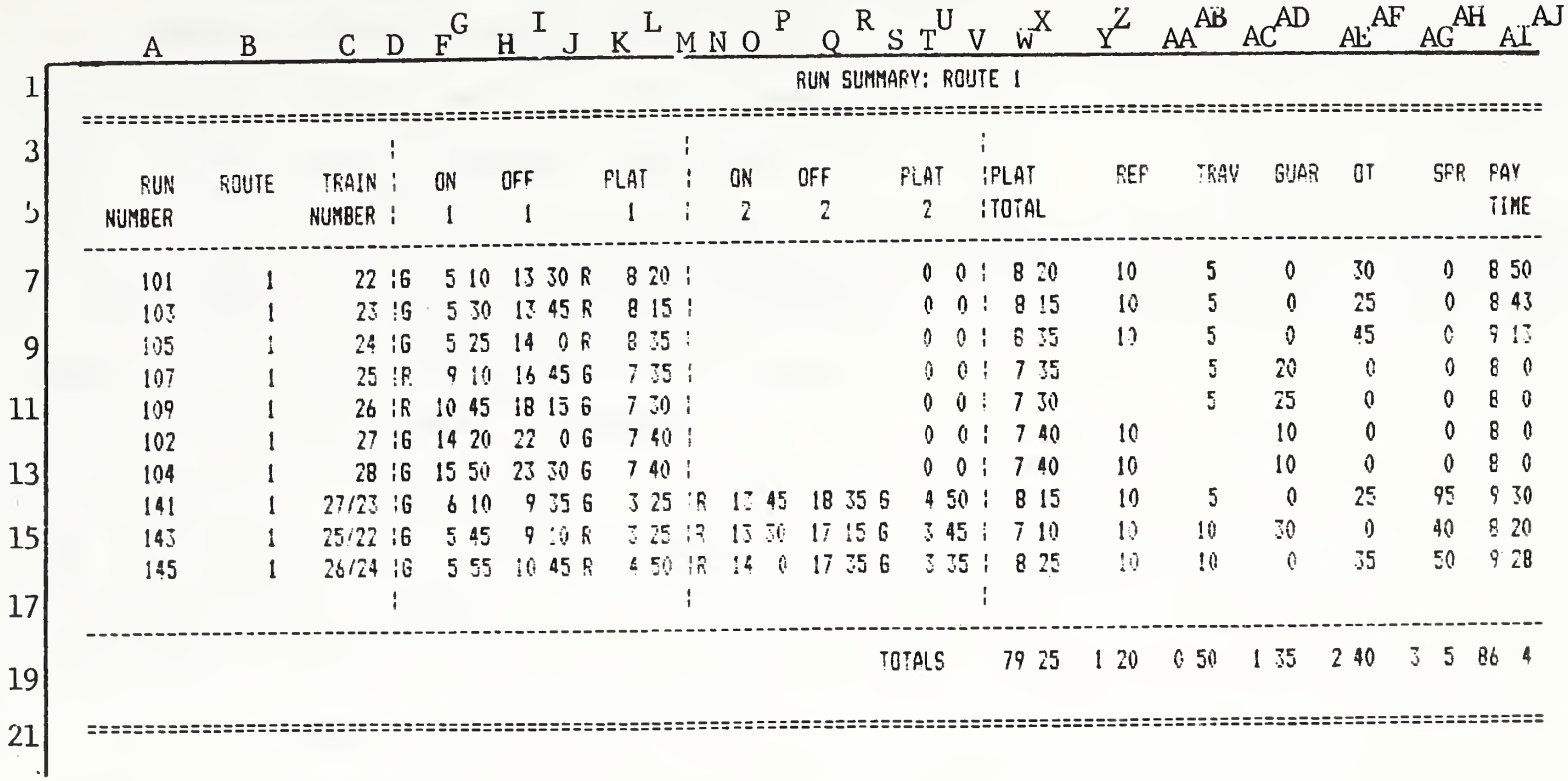
B7: Data. Run number (s).

C7: Data. Block number (s).

E7: Data. Code indicates origin of the run. R = relief G = garage

F7, G7: Data. Beginning time of the first piece of run 101.

H7, I7: Data. Ending time of the first piece of run 101.



RUN SUMMARY: ROUTE 1

RUN NUMBER	ROUTE	TRAIN NUMBER	ON 1	OFF 1	PLAT 1	ON 2	OFF 2	PLAT 2	PLAT TOTAL	REP	TRAV	GUAR	OT	SPR	PAY TIME
101	1	22	G 5 10	13 30 R	8 20			0 0	8 20	10	5	0	30	0	8 50
103	1	23	G 5 30	13 45 R	8 15			0 0	8 15	10	5	0	25	0	8 43
105	1	24	G 5 25	14 0 R	8 35			0 0	8 35	10	5	0	45	0	9 13
107	1	25	R 9 10	16 45 G	7 35			0 0	7 35		5	20	0	0	8 0
109	1	26	R 10 45	18 15 G	7 30			0 0	7 30		5	25	0	0	8 0
102	1	27	G 14 20	22 0 G	7 40			0 0	7 40	10		10	0	0	8 0
104	1	28	G 15 50	23 30 G	7 40			0 0	7 40	10		10	0	0	8 0
141	1	27/23	G 6 10	9 35 G	3 25	R 12 45	18 35 G	4 50	8 15	10	5	0	25	95	9 30
143	1	25/22	G 5 45	9 10 R	3 25	R 13 30	17 15 G	3 45	7 10	10	10	30	0	40	8 20
145	1	26/24	G 5 55	10 45 R	4 50	R 14 0	17 35 G	3 35	8 25	10	10	0	35	50	9 28
								TOTALS	79 25	1 20	0 50	1 35	2 40	3 5	86 4

Figure 10.23 Run Summary

J7: Data. Code indicates terminal of first piece of the run.
R = relief. G = garage.

K7: If (G7>I7) then (H7-F7-1), else (H7-F1)

L7: If (G7>I7) then (I7-G7+60), else (I7-G7)

Columns N through U: Same as columns E through L for the second piece of the run.

T7: If (P7>R7) then (Q7-07-1), else (Q7-07).

U7: If (R7<P7) then (R7-P7+60), else (R7-P7).

W7: (K7+T7+Int((L7 + U7)60)).

W19: Sum (W7..W16) + Int (Sum(X7...X16)/60).

X7: (L7+U7-(Int((L7+U7)/60))*60)

X19: Sum (X7..X16)-Int(Sum(X7...xX6)*60

Y19: Sum (Y7...Y16)+Int(Sum(Z7..Z16)/60)

Z7: Data. Paid report time for run 101, in minutes.

Z19: Sum (Z7... Z16)-Int(Sum(Z7...Z16)/60)*60

AA19: Sum (AA7...AA16)+Int(Sum(AB7...AB16)/60)

AB7: Data. Paid travel time for run 101, in minutes.

AB19: Sum(AB7...AB16)+Int(Sum(AB7...AB16)/60*60

AC19: Int(Sum(AD7...AD16)/60)

AD7: If (X7+Z7+AB7+W7*60>480) then (480-X7-Z7-AB7-W7*60), else 0.
The example guarantees 8 hours paid time per run.

AD19: Sum (AD7...AD16)-Int(Sum(AD7...AD16)/60)*60

AE19: Int (Sum(AF7...AF16)/60)

AF7: If (X7+Z7+W7*60-480>0) then (X7+Z7+W7*60-480), else 0.
The example property pays overtime for report time and platform time only in excess of 8 hours (480 minutes).

AF19: Sum (AF7...AF16)-Int(Sum(AF7...AF16)/60)*60.

AG19: Int(Sum (AH7...AH16)/60)

AH7: If ((Q7*60+R7) - (F7*60+G7)+Z7)>660) then (Q7*60+R7-F7*60+Z7-G7-660), else 0. The example property pays spread premium for spread over 11 hours (660 minutes). The formula assumes that the report time for all runs with excessive split occurs at the early report of the run.

AH19: Sum (AH7...AH16)-Int(Sum(AH7...AH16)/60)*60.

AI7: W7+Int((X7+Z7+AD7+AB7+.5*(AF7+AH7))/60)

AI19: Sum (AI7...AI16)+Int(Sum(AJ7...AJ16)/60)

AJ7: Round ((X7+Z7+AB7+.5*(AF7+AH7))-Int((X7+Z7+AB7+AD7+.5*(AF7+AH7))/60)*60,0)

AJ19: Sum (AJ7...AJ16)-Int(Sum(AJ7...AJ16)/60)*60

CHAPTER 11

DATABASE APPLICATIONS

Database managers may have the most profound long-term impact on transit management by dramatically increasing the amount of information available in a useful form to managers for decision-making. This increased amount of information allows managers to monitor the performance of the agency more closely, and to make decisions based on a more complete picture of the problem than was previously possible.

Database managers have been slower than spreadsheets to be adopted widely by the transit industry for a number of reasons:

-Database management programs capable of handling the complex requirements of the transit industry have, until recently, been difficult to learn and use.

-Database management applications are rarely self-contained. They usually require defining connections between data files and establishing operating procedures for maintaining the usefulness of the database.

-The power and benefits of database management are less immediately appealing than are those of spreadsheets.

Virtually any data which is maintained on forms or tables can be stored instead in a database manager. However not every case of such record keeping would benefit from it. Applications where automation offers real benefits include:

-Data which must be summarized or sorted in several different ways or which is referenced frequently.

-Large amounts of data which are particularly cumbersome to manipulate. Data which is accumulated and analyzed over long time periods could be included in this category.

Documentation

The fields included in each record are listed under "file structure." The length of each field will depend on the particular characteristics of the agency. Notes are provided on some data items. Notes beginning "=..." represent calculated data fields in which the contents is calculated from other data for the record. The types of data fields vary between database managers, and are not included here.

The section entitled "Reports" suggests some of the ways in which the data can be summarized or analyzed for management purposes.

"Complementing files" includes a list of other files which would enhance the use of the documented file as part of a system.

DOCUMENTATION: CUSTOMER SERVICE RECORDS

Application

A database manager is used to monitor the status of response to customer complaints, suggestions, and commendations.

Use

Customer contacts are recorded on a four-part form as they are received. The form includes: a serialized report number; data on the customer; the time, location, and nature of the comment; which department it is referred to and date of referral; response of the department referred to; and response by customer service to the customer. Data on the content of the contacts and action taken in response to each communication is entered daily using the database manager. This data is used to generate reports to monitor the progress of responsive action.

File Structure

	Data Item	Comments
1.	Report #	Number from form
2.	By/re	Staff initials/c=letter, p=phone
3.	Date in	Date received
4.	Customer name	Defaults to "not given"
5.	Complaint	50 spaces provided
6.	Date occured	
7.	Time occured	
8.	Route #, Direction	
9.	Bus #	
10.	Location	
11.	Employee #	
12.	Department referred to	Ops, Maint, Mktg, & Plng
13.	Date to respond by	
14.	Date received from department	Defaults to "open"

15. Response to customer

16. Date of response

17. Closed date

Reports

Reports generated from the file include:

1. Summary of Customer contacts by month, and by department referred to. Data items 12, 2, 3, 5, 8, and 1 are included in the report.

2. Report of contacts not yet closed by department referred to.

3. Report of contacts by route and type.

DOCUMENTATION: CLIENT RECORDS

Application

Database management is used to maintain client records for human service transportation.

Use

Data on registered clients is maintained in the file. Information in the file can be referred to for scheduling, billing, mailings and ridership summaries.

File Structure

	Data Item	Comments
1.	Client ID no.	
2.	Name	Last
3.	Name	First, Middle
4.	Street Address	
5.	City	
6.	State	
7.	Zip	
8.	Phone number	
9.	Alternate phone number	
10.	Certifying agent	Individual doctor, etc.
11.	Agent address	Agency or address
12.	Agent phone	
13.	Client Soc. Sec. number	
14.	Handicap/aid required	B=blind, C=cane, walker, etc.

Reports

1. List of clients by certifying agent.
2. Mailing lists by area, certifying agent, or type of handicap.

Complementary Files

1. Certifying agents
2. Scheduled trips

DOCUMENTATION: PARTS INVENTORY

Application

This simple application of database management to parts inventory can be used to track stock quantities and maintain parts order information. This material is based on the parts inventory on DBMaster™ distributed by the TIME Support Center.

Use

Once the parts information is input, 4 types of transactions are entered in the file: parts withdrawals, parts restocking, orders placed, and orders received.

File Structure

	Data Item	Comments
1.	Part name	
2.	Date of last change	Updated automatically, when the parts record is changed.
3.	UPC	Uniform or manufacturer's part code number
4.	Stock number	
5.	Bin location	
6.	Number in stock	Updated when parts are added or withdrawn from inventory
7.	Order threshold	
8.	Slack	=number in stock - order threshold. When slack is less than or equal to 0 an order is needed.
9.	Last price	Unit price of part
10.	Stock value	=number in stock * last price
11.	Last withdrawal date	Updated when part is withdrawn

	Data Item	Comments
12.	Number withdrawn	Number of units withdrawn at last withdrawal date.
13.	Order outstanding?	Y or N for yes or no. Should be changed each time an order is submitted or delivered.
14.	Last order date	Update when order is submitted.
15.	Purchase order number	Update when an order is submitted.
16.	Number ordered	Update when an order is submitted.
17.	Unit price	Update when an order is submitted.
18.	Total cost	= number ordered * unit price
19.	Date received	Update when an order is received.

Reports

1. Orders needed, all parts with slack less than or equal to 0, and order outstanding equal to N.
2. Stockouts, all parts with number in stock less than or equal to 0.
3. All parts not withdrawn since a specified date.
4. Orders outstanding for parts which have not yet been received.

Complementary Files

1. Alternate suppliers of parts
2. Work orders specifying parts used
3. Orders placed

APPENDIX A

GLOSSARY

APPENDIX A

GLOSSARY

Address bus. The path used by the CPU to identify locations in memory.

Application program. A program designed to perform a practical task, such as accounting, parts inventory, or route costing.

ASCII. American Standard Code for Information Interchange. A standard for representing the characters of the alphabet, numerical digits and punctuation in binary code (1s and 0s.)

Asynchronous port. Same as serial port.

Auto dial, Auto answer modem. A programmable modem which can store and dial telephone numbers or answer incoming calls without user involvement.

Backup. A copy of a program or data made for protection in case the original is damaged.

BASIC. Beginner's All-purpose Symbolic Instruction Code. An easy-to-learn, high-level programming language, much used on microcomputers.

Baud rate. Rate of data transfer over telephone lines in bits per second. Standard rates are 300 and 1200 baud.

BIOS. Basic Input Output System. Part of the operating system which controls input and output devices attached to the computer, including the keyboard, monitor, and printer.

Bit. Binary Digit. The smallest division of computer data, either 1 or 0.

Bit size. The number of bits processed as a group by a CPU microprocessor.

Board. A resin board holding chips and circuitry which enhances the computer's operation. Boards can be purchased as an option and plugged into one of the computer's expansion slots.

Boot. To turn on a computer and load the operating system into memory, preparing it for use.

Buffer. Memory used as temporary storage for data being transferred between the computer and a peripheral.

Bus. A path over which data travels between parts of a computer system.

Centronics. The standard connection for parallel communication.

Chip. A tiny integrated circuit etched on a silicon wafer. A chip can be a microprocessor or memory.

Clock speed. The speed at which a microprocessor operates, measured in megahertz or millions of cycles per second.

Command. An order to the computer to execute a task.

Command-driven. A program used by giving commands known by the user, rather than by selecting from a menu.

Compiler. Software which translates a program written in a high level language (source code) into binary object code understood by the CPU.

Controller. A microprocessor which coordinates a peripheral device (printer or monitor, for example) with the CPU.

Coprocessor. A microprocessor used to supplement the CPU by performing specialized tasks.

Copy protection. Techniques used by software distributors to prevent unauthorized copying or distribution of their programs.

CPU. Central Processing Unit. The microprocessor that does the actual computing and controls the flow of information in the computer.

CRT. Cathode Ray Tube. A video display monitor.

Cursor. A marker which moves around the monitor screen to show you where you are in the text or program.

Daisywheel printer. An impact printer using raised inverted letters at the end of the petals of a metal or plastic "daisy".

Database. A collection of information, organized for easy analysis and retrieval. May be a group of files.

Database manager. A program which allows the user to organize, build, and use a database.

Data transmission adapters. Devices which permit the computer to transmit data to and receive data from peripheral devices by using a predefined format.

Debugger. Software which helps a user to identify and correct program errors by following the detailed operation of the program.

DIF. Data Interchange Format. A standard format for data, permitting transfer of data between programs which use the DIF standard.

Disk, diskette, floppy disk. A plastic magnetic disk which is the most usual medium for recording and storing data.

Disk drive. A piece of equipment which reads data from and writes data on a disk as directed by a program and the CPU.

Documentation. The material which accompanies the program to teach the user how to use it and provide information for future reference.

Dot matrix printer. A printer which forms letters and images from rows and columns of tiny dots.

Erasable Programmable Read Only Memory. (EPROM) Memory which is not erased when the computer is turned off, and which can be programmed and erased by users.

Error trapping. A method for checking input to a program by comparing data with acceptable or unacceptable input values and rejecting unacceptable data with a message to the user.

Electroluminescent display. A display used on some portable computers in which characters are formed by wires which glow when current is passed through them.

Expansion slot. See slot.

File. A collection of data treated as one unit which can be a program, a piece of text, or statistical information.

File Manager. A program which allows the user to organize, build and use a file of data.

Fixed, hard, or Winchester disk. A permanently installed metal magnetic disk capable of holding large amounts of information, and rapid reading and writing of data.

Format. A pattern of subdividing a disk to organize the information written on it. Also a standard way of writing data so that it can be understood by a program.

Full-duplex modem. A modem permitting data to be transferred to and from it simultaneously.

Generic software. Programs which can be used as a multi-purpose tool, rather than having a specific application. Word processors, spreadsheets or database managers are common examples.

Half-duplex modem. A modem which can only transmit or receive data at a time.

Half-height. A compact design for disk drives, half the volume of the standard size.

Hard copy. Program output printed on paper, as opposed to that displayed on the monitor.

Hard disk. Fixed disk.

Hardware. The physical components of the computer, as opposed to the programs or software.

High level language. A computer language using English-like words, which must be translated by a compiler or interpreter before the CPU can understand it.

Ink jet printer. A printer which prints characters by shooting ink out of a grid of tiny nozzles.

Integrated programs. Programs which perform different functions but are designed to be used together as a package.

Interpreter. A program which translates a high-level language program into machine language step by step as it runs.

Kilobytes. (K) About 1000 bytes of memory.

Keyboard. A device resembling a typewriter keyboard used for input of information to the computer.

Letter quality printer. A printer which produces text of the same quality as an electric office typewriter.

Light pen. A device used to identify points on the monitor screen.

Liquid crystal. A type of display found in small computers where liquid is darkened by applying an electric field to it.

Local Area Network. (LAN) A system of hardware and programs for connecting microcomputers to each other and allowing them to share peripherals.

Megabyte. One million bytes, approximately.

Machine Language. The language made up of 0s and 1s is understood by the CPU.

Macro. A series of spreadsheet commands, stored and executed as a group.

Mass storage. Peripheral devices, such as disk drives, used to store data.

Menu. A list of options displayed by the program from which the user can select a command.

Menu-driven. Programs which are operated by the user selecting from menus of choices.

Microprocessor. A chip which performs computations or controls information flow, such as the CPU.

Modem. Modulator-Demodulator. A device which translates data from a computer's serial port into modulated signals to be sent over a telephone line and converts incoming signals back into a form understood by the computer.

Monochrome. A monitor which displays tones of a single color.

Mouse. A device which the user rolls across a desktop to move the cursor.

Monitor. The television-like display used for viewing computer output.

Multi-processor. A computer containing two microprocessors which can be selected as alternate CPUs.

Multi-tasking. A computer which can perform several tasks at one time by dividing CPU time between them.

Multi-user. A computer which can be used by several operators at a time from separate keyboard terminals.

Object code. The form of a compiled program in machine language which can be executed by the computer.

Off-the-shelf. Software which is widely commercially distributed and can be purchased at computer stores.

Operating system. A master program which allows the computer to run other programs by controlling flow of data between the CPU and peripherals.

Optical scanner. A device which reads special markings, such as bar codes, for direct input to the computer.

Network. See Local Area Network.

Package. A group of programs distributed as one product.

Parallel port. A port which transmits 8 bits of data, or a byte, simultaneously.

Peripherals. Devices which are plugged into the computer, such as disk drives and printers.

Pixel. A dot on a monitor display, many of which make up the image.

Port. An outlet through which the computer can communicate data.

Printer. A device which prints computer output on paper, creating hard copy.

Program. A collection of commands to the computer to be executed as a group.

Programmable read only memory. (PROM) Blank read only memory which can have a program written on it permanently.

Protocol. Standard conventions which allow two computers to coordinate communications.

Random access memory. (RAM) Internal memory on chips which is erased when the computer is turned off.

Read only memory. (ROM) Permanently programmed memory which holds programs installed by the computer manufacturer.

Resolution. The quality of image on a monitor display, affected by the size and number of dots or pixels on the display.

Record. A collection of information treated as a unit. A number of records make up a file.

RS-232-c. The standard for serial or asynchronous ports.

Sector. A portion of a diskette treated as one unit for reading and writing data.

Serial port. A port through which data is transmitted one bit at a time. Signals are used to indicate when each byte, or group of 8 bits, stops and starts.

Slot. An outlet on the bus for plugging in boards containing additional memory, controllers or other enhancements of the computer.

Software. Programs and languages used with a computer system.

Source code. The text of a program in a high-level language.

Spooler. A program which designates some portion of RAM to serve as buffer for temporary storage of material to be printed.

Spreadsheet. A program used to set up and manipulate large tables of information.

Surge protector. A device placed between the wall outlet and power cable of the microcomputer to protect the computer from damaging voltage surges.

System software. Software supporting application programs, including the operating system, programming languages and utilities.

Text editor. A program which allows the user to enter and change text stored in a file.

Text formatter. A program which allows the user to format text for printing by controlling margins, page length, indentation, and so on.

Thermal printer. A printer which forms images by heating points on heat sensitive paper.

Thimble printer. An impact printer which uses raised inverted letters on "thimble" shaped piece.

Track. A concentric circle on a disk used for defining and locating storage sections on a disk.

Tutorial. A simulated application of a program provided to introduce users to the program.

Utilities. Programs used to enhance the use of the computer and increase control and flexibility of computer use.

Winchester disk. Fixed disk.

Window. An area of the monitor screen used to display different applications or portions of the same application.

Word processor. A program for entering, editing, and formatting text documents.

APPENDIX B

REFERENCES

SOURCES OF INFORMATION ON MICROCOMPUTERS

UMTA

Three publications by UMTA are available from:

Microcomputer Reports
c/o Price Williams
962 Wayne Avenue, Suite 500
Silver Spring, MD 20910

Their titles are:

Selected Readings, Volume 1, Getting Started in Microcomputers

Selected Readings, Volume 2, Selecting a Single User System

Software and Source Book

Transit Industry Microcomputer Exchange (TIME)

The Transit Industry Microcomputer Exchange is a federal sponsored microcomputer users group. They publish a newsletter, "TIME Capsule," and distribute public domain software developed by other users. Their address is:

TIME Support Center
Rensselaer Polytechnic Institute
Civil Engineering Department
Troy, NY 12181
(518) 266-6227

National Cooperative Transit Research and Development Program (NCTRP)

An inventory of software on all computers at transit agencies is being conducted for NCTRP. For information on the status of this project contact:

Mr. Harry Smith
Projects Engineer
Transportation Research Board
2101 Constitution Avenue, N.W.
Washington, DC 20418
(202) 335-3224

Periodicals

Numerous periodicals are available which offer various perspectives on the microcomputer industry and uses. They are particularly helpful for comparative reviews which describe the use and attributes of the type of product. Reviews of specific products vary in usefulness, depending on the willingness of a particular periodical to honestly describe a product's shortcomings.

Some of these periodicals are obtained by most public libraries and they are widely available at newsstands.

General Magazines

Magazines which deal with the industry as a whole, without focusing on particular types of product are helpful for becoming familiar with the technology and its uses. Once a type of microcomputer has been selected they become less helpful, because material on other types of microcomputers may not be relevant.

Personal Computing is a readable general magazine which is helpful for its general discussions of computer uses and products. Monthly. $18/year.

Personal Computing
P.O. Box 2942
Boulder, CO 80322

Popular Computing is a readable general magazine which has useful overviews of product types and applications. Monthly. $15/year

Popular Computing
P.O. Box 307
Martinsville, NJ 08836

InfoWorld is a newsmagazine on the computer industry. Its descriptive no-holds-barred reviews of specific software and hardware products are particularly useful. Weekly. $31/year.

Info World
375 Cochituate Road
Framingham, MA 01701

BYTE is a thorough, more technically oriented magazine. It contains comprehensive discussions of product types and ways of using microcomputers. Monthly. $21/year.

BYTE
P.O. Box 590
Martinsville, NJ 08836

Product-Specific Magazines

If you have selected a particular type of microcomputer it is helpful to obtain one of the magazines specific to a microcomputer type. Because of their well-defined focus these offfer techniques and suggestions of immediate value in using the microcomputer and help the reader to understand and explore the range of abilities of the machine.

For the IBM PC and compatibles:

PC World. Monthly. $24/year (14 issues)

PC World
555 De Haro Street
San Francisco, CA 94107

PC Magazine. Bi-weekly. $34/year

PC Magazine
PC Communications Corp.
One Park Avenue
New York, NY 10016

For Apple microcomputers:

nibble. Monthly. $26.95/year

nibble
P.O. Box 325
Lincoln, MA 01773

Business Computer Magazines

A number of periodicals treat the use of computers within organizations. In addition to the technical aspects of automation these magazines discuss issues of management, personnel, and decision-making in relation to computers. Many of them include microcomputers as well as larger computer systems. Two of these are:

Business Computer Systems
270 St. Paul Street
Denver, CO 80206

Monthly, free to business personnel responsible for computers, $35/year for others

Computer Decisions
P.O. Box 1417
Riverton, NJ 08077

16 issues/year. Free to executives of organizations that use computers. $35/year for others

Software Reviews

An independent service which reviews software for the IBM PC is Software Digest Ratings Newsletter. Each monthly report covers one type of software, and rates programs on a variety of criteria. Monthly. $135/year.

Software Digest
One Wynnewood Road
Wynnewood, PA 19096

ARTICLES OF INTEREST

General

Annual Software Review, PCWorld, 1983/1984. An inventory of software for the IBM PC. Provides a good overview of the range and capabilities of available products.

VanDiver, Gerald, IBM Personal Computer XT: The Software Guide, Micro Information Publishing Inc., Prior Lake, Minnesota, 1983.

Chapter 2: System Design

PC World

"Blueprint Your Database," by Manuel Sotomayor, Vol. 2, No. 7, July 1984.

Personal Computing

"Overcoming Computer Resistence," by Arielle Emmett, Vol. 7, No. 12, December 1983, p. 80.

Getting Started in Microcomputers: Selected Readings Volume 1

"Microcomputer Applications in Human Service Agencies" by James B. Taylor with Jacque Gibbons. Reprinted from Human Services Monograph Series. Although it is written for human services agencies this paper presents a practical approach to needs assessment. Available free from address given under UMTA above.

Selecting a Single User System: Selected Readings Volume 2

"Microcomputers in Transportation: Selecting a Single User System" by Richard Albright. Available free from address given under UMTA above.

Chapter 3: Generic Software

BYTE

"The Word Processing Maze" by Andrea Lewis and "Evaluating Word Processing Programs" by Arthur Naiman, Vol. 9, No. 2, February 1984, p. 235 and 243.

"Statistical Software for Microcomputers: A Comparative Analysis of 24 Packages," by James Carpenter, Dennis Deloria, and David Morganstein, Vol. 9, No. 4, April 1983, p. 234.

PC Magazine

"Project Database", Vol. 3, Nos. 11 to 16. June 12, 1984 to August 14, 1984. Nos. 11, 12, and 13 cover file managers. No. 14 covers relational database managers handling 2 files with a query language. Nos. 15 and 16 cover database managers with a procedural language.

PC World

"Lotus" Symphony: Three User Reports," PCWorld, July 1984.

"War of the Words, by Burton L. Alperson, November 1983. Comparative review of Microsoft Word, VisiWord, and WordStar.

Personal Computing

"Word Processing for Printers: Finding the Right Fit," by Arielle Emmett, Vol. 8, No. 8, August 1983, p. 122.

"Relational Data Bases that Take on the 'Big' Jobs", by Elliot King, Vol. 8, No. 5, May 1984, p. 122. Includes a table comparing database products.

"Picking the Perfect Word Processor", by Arielle Emmett, Vol. 8, No. 5, May 1984, p. 112.

"How to Buy Data-Base Software", by David Gabel, Vol. 8, No. 2, February 1984, p. 116.

Popular Computing

"Software Integration", by Michael J. Miller, Vol. 3, No. 2, December 1983, p. 106.

"Word Processing: Finding the Right Software", by David Gabel, Vol. 7, No. 4, April 1983, p. 110.

Business Graphics are the subject of a special issue, Vol. 3, No. 1, November 1983. Articles include "A Guided Tour of Business Graphics", by Larry McClain, p. 86.

"Statistical Software", by Peter Callamaras, Vol. 2, No. 12, October 1983, p. 206. Includes comparative reviews of 7 programs.

Chapter 4: Application Software

Software and Source Book. This publication lists application software, both public domain and proprietary, for transportation applications including transit. It is available free from the address listed under UMTA above.

Chapter 5: Operating Systems

Computer Decisions

"Broadening your Personal Computers' Horizons", by Susan Foster, Vol. 16, No. 1, January 1984. Overview of available operating systems.

PC Magazine

"Live Free with UNIX, by Eric S. Raymond, Vol. 3, No. 10, May 29, 1984, p. 145.

PC World

"Understanding Operating Systems," by D.M. Tucker, Vol. 2, No. 5, May 1984. Explanation of the functions of the operating system.

"Understanding UNIX", by Mark Zachmann, Vol. 3, No. 10, May 29, 1983, p. 155.

Popular Computing

"Operating Systems," by Rick Cook, Vol. 3, No. 10, August 1984.

"The UNIX Operating System and its Clones" by Bernard Cole, Vol. 2, No. 7, May 1983, p. 106.

Chapter 6: Programming Languages

BYTE

"Is BASIC Getting Better?", by C. Michael Vose, Vol. 9, No. 4, April 1984, p. 298.

Chapter 7: Utilities

PC World

"Remote and Unattended", and "A Host of Hosts", by Larry Jordan, Vol. 2, No. 2, February 1984. Description of auto-answer communications programs and comparison of 6 programs.

"The Communicators", by Larry Jordan, Vol. 1, No. 5, Explanation of communications software and comparison of 12 communications programs.

Popular Computing

"What Do You Do After You Plug It In? - Talking in Tones", by William Barden, Vol. 3, No. 2, December 1983, p. 65.

Communications are discussed in a special issue, Vol. 3, No. 4. Articles include "Data Communications for Personal Computers", by Edwin E. Mier, p. 98; "The Micro to Mainframe Connection", by Charles Feltman, p. 104; and 'Micro-to Micro Communications" by T. J. Byers, p. 112.

"Buyers Guide to Communications Software", by David B. Powell, Vol. 3,

No. 9, p. 121.

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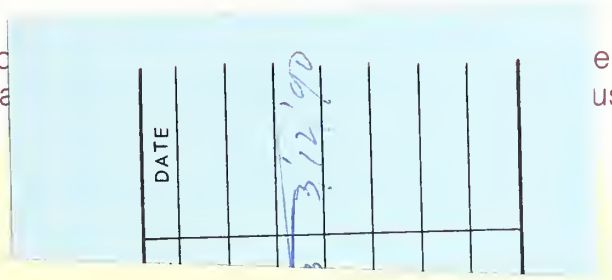

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